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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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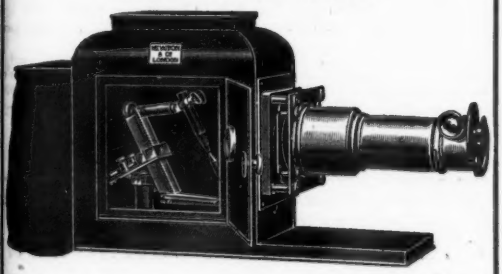

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THURSDAY, APRIL 22, 1920.

The Promotion of Medical Research.

IT is evident from the correspondence evoked by the leading article in NATURE of February 19 that many scientific workers are keenly interested in the subject of the organisation of scientific research and watch with some apprehension the efforts made to bring original investigators within an official system. Francis Bacon supposed that all scientific investigation must proceed from the general to the particular according to a prescribed set of rules, and gave in his "New Atlantis" "a modell or description of a college, instituted for the interpreting of Nature, and the producing of great and marvellous works for the benefit of man." As every student of the history of science knows, Bacon's method, and all other assumedly infallible systems for creating knowledge, fail to furnish a formula for scientific discovery. New truths present themselves in unexpected places, and the seeker after them has to follow whatever paths seem to be the most promising. Knowing that this is so, and cherishing the freedom of action of true explorers, men of science view with suspicion any schemes for systematising research which may deprive them of their birthright. They do not, however, form a single corporate body concerned solely with the promotion of discovery by the encouragement of genius; wherefore they are rarely considered when research systems are planned by the Bacons of our day.

It was pointed out by Prof. Soddy in NATURE of February 26 that the position is different in medical science, because in this case the profession is able to exact due and proper respect for its members, and to insist, therefore, upon administrative and other conditions which they consider best suited to their needs or to solve the problems with which they are concerned. The recent incorporation of the Medical Research Committee as the Medical Research Council is a very notable event in this connection. After its seven years' work under the National Health Insurance Department, the Committee has been transferred to its new position as the Medical Research Council, under the direction of a small Committee of the Privy Council consisting of the Lord President, the Minister of Health (England and Wales), the Secretary for Scotland, and the Chief Secretary for Ireland for the time being. The Council has been incorporated with a perpetual succession by Royal charter, with powers to hold and use not only moneys and land derived from Parliament, but also property or trusts vested in it by private persons or bodies. It is not merely an Advisory Council, but is in charge of its own executive. These main features sufficiently mark the interest and importance of the new step now taken towards solving that difficult problem in the art of government—the preservation of the freedom and self-government of scientific research work as to both initiative and execution, with due regard to a just responsibility to Parliament in respect of State endowment.

The appointment of the Development Commission in 1911 marked the first modern step towards a solution of this problem of the State endowment of research. For the first time an organisation independent of the administrative Departments was set up to initiate and direct scientific research work in particular directions. The constitutional position of the Commission was anomalous, its functions were too various in kind, and the *personnel* selected for it suffered in quality, perhaps, because it depended too much upon the representative principle. But the work of the Commission, especially in relation to agricultural research, was in charge from the first of scientific men, and in effect, if not in form, the Commission had executive as well as advisory powers.

The next landmark in this development was the formation of the Medical Research Committee in 1913 in connection with the National Health Insurance Department. This was attached directly to an administrative Department, but it was given a singularly free constitution. The Committee was composed of scientific men appointed for their quality as counsellors without subservience to any representative principle; it was empowered to appoint and dismiss its own servants, and it had full executive authority within the widest limits of research schemes of its own initiation when these had received general Ministerial approval.

The outbreak of war brought home to the Government the grave national need for a wider and more liberal State endowment of research. In 1915 a scheme for public expenditure upon scientific and industrial research was developed under the Board of Education, where Dr. Addison was then Parliamentary Secretary. It was natural that this should be modelled in its early stages upon the system of the Medical Research Committee, of the working of which there had already been two years of useful experience; but the new organisation soon departed from that model in some essential points. It was early and

rightly transferred to the Privy Council, where it had independence from any one administrative Department, and could serve all Departments alike. But the council of scientific men became a purely advisory body, as it now is, and the Committee of Privy Council under which the work was to be done was not purely Ministerial and formal, but received the addition of other personally appointed lay members in a position constitutionally superior to that of the scientific members of the Advisory Council. A strong staff of lay officers was progressively appointed upon the executive side as a Department under the Privy Council Committee, not under the direct control of the scientific members of the Advisory Council, and neither appointed nor removable by them.

When the Ministry of Health for England and Wales was constituted in 1919, with corresponding Boards of Health in Scotland and Ireland, the disbanding of the four National Health Insurance Commissions made a new constitution necessary for the Medical Research Committee, the work of which in science has no national boundaries. It could not properly be attached to the Ministry of Health, because, altogether apart from the general arguments against placing a system of free research work under a strong administrative Department, a Committee serving the whole of the United Kingdom could not fittingly be attached to a Ministry responsible only for England and Wales. The obviously right course was to bring the medical research service under the Privy Council, the range of which not only covers the United Kingdom, but also allows easy constitutional relationship with systems of research work throughout the Empire. The problem was to bring the Medical Research Committee into close relationship with the scientific and industrial research system already under Privy Council direction, and equally with other systems that may hereafter be placed there, so as to allow the greatest possibility of co-operation along the innumerable boundary lines of scientific work; at the same time it was necessary to do this without sacrificing any of the freedom which the Committee had already enjoyed in its first constitution, or had worked out in experience and established in its traditions.

The solution of this was given when the new Committee of Privy Council for the work of the Committee—now the Medical Research Council—was established by Order in Council on March 11 last. This Committee provides the formal Ministerial responsibility for moneys provided by Parliament, and at the same time it represents and brings together the interests of all the four parts of the Kingdom. In the absence of the Lord President, the Minister of Health will act as Vice-President of the Committee. The Secretary appointed by the Medical Research Council for its own scientific and administrative purposes is to be *ipso facto* Secretary of this Privy Council Committee, so that the chief executive officer of the Research Council will have direct access to the Minister in charge, without the intervention of lay officials either now or in the future.

The Medical Research Council itself has been incorporated by Royal charter in perpetual succession with legal powers to hold money or other personal property, whether voted by Parliament or derived from other sources, and to accept trusts for the furtherance of medical research. It has licence to purchase and hold land or to receive it by gift or bequest up to an annual value of 50,000*l.*, determined at the time of acquisition.

The personal constitution of the Medical Research Committee upon becoming the new Council is little changed. At least two of its members must always be Members of Parliament, one each in the House of Lords and the House of Commons. Lord Astor and Dr. Addison, holding office in the Ministry of Health, retired from the Committee before the change was effected, and one additional scientific member was appointed, to bring the total number from nine to ten. The constitution of the final Medical Research Committee and of the new Medical Research Council is as follows:—The Viscount Goschen; Mr. William Graham, M.P.; the Hon. Edward Wood, M.P.; C. J. Bond, C.M.G., F.R.C.S.; Prof. W. Bulloch, F.R.S.; Dr. T. R. Elliott, F.R.S.; Dr. Henry Head, F.R.S.; Prof. F. Gowland Hopkins, F.R.S.; Major-Gen. Sir William Leishman, K.C.M.G., F.R.S.; and Prof. D. Noël Paton, F.R.S.

It is laid down that three of these members shall retire on September 30, 1921, and thereafter three at intervals of two years. Vacancies so caused or arising casually are to be filled by appointment by the Committee of Privy Council, but only after consultation with the President for the time being of the Royal Society and with the Medical Research Council. This provision will bring into effective bearing upon the constitution of the

Council the best scientific opinion of the time through the channel of the Royal Society, which is likely to be all the more effective because it is not a formal nomination to be made by a busy Royal Society Council among other business, and it gives direct access by the President to the responsible Ministers. A further important provision is that the charter itself may receive amendment or addition, if majority votes of the Council under stated conditions be obtained and the change be allowed by the Committee of Privy Council.

We have continually urged in these columns that scientific men themselves should decide upon the allocation of funds for research, as is done by the Royal Society, the British Association, and other bodies; and that they should be responsible for any schemes of organised investigation. Friction and misunderstanding always arise when these functions are performed by official administrators unfamiliar with such a sensitive plant as scientific genius and unable to judge the promise of incipient inquiry. The remedy for such difficulties is always to ensure that the men who do the work are the masters of the administrative machine and have confidence in the direction of it by specially qualified colleagues—to promote, in fact, the same spirit of common interest between director and worker that is desired between capital and labour. The Medical Research Council seems to fulfil these conditions in every respect, and its incorporation marks a noteworthy stage in scientific development. The Council can determine its own policy, has complete control of its funds, is in direct touch with progressive science by association with the Royal Society, and, above all, its Secretary, Sir Walter Fletcher, has the full confidence of medical research workers. He knows well enough the truth of the adage *Poeta nascitur, non fit* as applied to scientific genius, and may therefore be trusted to secure the most favourable conditions for the development of this rare fruit when it appears.

During its existence the Medical Research Committee brought together a brotherhood of research workers whose scientific investigations have been of the highest national value, and it did this without limiting the freedom of action which is their heritage. We confidently look to the new Council to encourage the independent investigator as well as to create a reserve of research workers, and thus consolidate the organisation of scientific effort in the service of medicine so well begun by the Committee which it supersedes.

A Study in Palæogeography.

The Environment of Vertebrate Life in the Late Paleozoic in North America: A Paleogeographic Study. By Prof. E. C. Case. (Publication No. 283.) Pp. vi+273. (Washington: Carnegie Institution of Washington, 1919.) Price 3 dollars.

THE following passage from Suess's "Face of the Earth" might be taken as an appropriate text for the work under consideration:—"It is the organic remains, no doubt, which afford us our first and most important aid in the elucidation of the past. But the goal of investigation must still remain the recognition of those great physical changes in comparison with which the changes in the organic world only appear as phenomena of the second order, as simple consequences." Prof. Case's volume may be described as an attempt both to provide an up-to-date corpus of material, often presented in the form of lengthy quotations from the writings of American geologists, bearing upon the history of the later Palæozoic period, and to utilise the data as evidence in an inquiry into the physical and climatic conditions under which organisms lived, migrated, or became extinct in different regions of the North American continent.

The author has essayed a difficult but attractive task, and though his own conclusions and generalisations are to some extent overwhelmed by the superabundance of citations from published sources, he has succeeded in making a valuable contribution to a neglected branch of geological history. He takes a broad view of the conception of environment; it represents "the sum of all the contacts which any organism or group of organisms establishes with the forces and matter of its surroundings, either organic or inorganic." The difficulty is that we have comparatively little knowledge of the nature of the interaction of existing organisms and their environment; but it is none the less praiseworthy to extend ecological inquiry to a remote era in the hope that in this line of research, as in others, a knowledge of the past may help us to solve the problems of the present.

In the first chapter Prof. Case discusses the different categories of facts which it is essential to consider in connection with palæogeographical questions, the nature of the sedimentary deposits, the source of the sediments, the history of the flora and fauna—whether they were evolved where they were preserved, or had migrated from another locality—the influence of environment reflected in the morphological characters of animals and plants, and other factors. He empha-

sises the importance of close co-operation between palæontologists and geologists in all matters relating to past geographies, and deprecates the over-readiness of the former class of workers to assume the existence of land-barriers. In illustration he refers to the continent of Gondwanaland, the existence of which "depends more definitely upon biological evidence and awaits full confirmation." Gondwanaland is, however, by no means the creation of palæontologists alone; its foundations are also geological. Succeeding chapters are devoted to the description of different provinces of North America in the latter part of the Palæozoic era, and the author summarises the results of an intensive study of Upper Pennsylvanian and Permo-Carboniferous rocks in certain areas. It is difficult for a reader not conversant with American stratigraphy to interpret the formations mentioned in terms of European classification, and one feels the lack of more helpful correlation-tables than those provided.

One of the most valuable features of the book is the emphasis laid on the necessity for regarding fossils as once living things, and for considering their distribution in the strata in relation to the problems presented to them by their environment. The chapter on the climatology of the later Palæozoic is a particularly useful mine of information. In the concluding chapter the author discusses the development and fate of vertebrate life in the Permo-Carboniferous period in relation to physical conditions. During Early Pennsylvanian time the conditions were singularly uniform over large areas, and the climate was equable and humid; a monotonous environment implies a limit to the number of genera and species in a flora or fauna; older and simpler types would persist because the variants, which were possibly being constantly produced, would not have a chance to develop. This idea is elaborated, though not so clearly as one could wish. It is suggested that the Upper Pennsylvanian fauna, though hampered in its further progress by the monotony of the environment, was accumulating force preparatory to a great radiation which would find expression when the limitations were removed. Prof. Case adds: "The fauna, long restrained from any expression of its evolutionary tendencies, full fed, and in the vigour of its youth, responded at once to the change, and new forms appeared so suddenly as to be unheralded in the preserved remains." This and similar passages illustrate the more imaginative side of the author's work.

The palæobotanical data are largely taken from the contributions of Mr. David White, whose researches are well known. The American Coal Measures have unfortunately yielded scarcely any petrified material comparable with that from England and a few other European countries, and although there is a wealth of plant impressions, anatomical criteria of climatic conditions are not available.

A. C. SEWARD.

Wheat and Wheat-growing.

Essays on Wheat. By Prof. A. H. R. Buller. Pp. xv+339. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 2.50 dollars.

PROF. BULLER'S "Essays on Wheat" are among the most interesting things we have seen for a long time. As professor of botany in the University of Manitoba, he has unrivalled opportunities of studying the ramifications of the wheat industry, for in no city in the world is wheat so important as in Winnipeg. He is singularly fortunate in his subject, and he tells his story remarkably well, giving the wealth of detail, the figures, and the references needed by the man of science, without sacrificing interest or literary form.

The first essay deals with the early history of wheat growing in Manitoba. It is a story in which Parkman would have revelled. The first attempt was made in 1812 by a little band of pioneers sent out from Scotland by Lord Selkirk to colonise the 116,000 sq. miles of territory granted to him by the Hudson Bay Co.; they settled at the junction of the Red and Assiniboine rivers where Winnipeg now stands. The first crop failed, as also did the second. The failure is scarcely surprising. "There was not a plow in the whole colony, the one harrow was incomplete and could not be used, and all the labour of breaking up and working over the tough sod had to be done with the hoe." The Indians were amazed, and nicknamed the colonists "jardiniers." Fortunately for the settlers, potatoes and turnips did well, or they must have had two very bitter winters. The third crop succeeded. But the troubles were by no means at an end. Birds were a great nuisance, especially the now extinct passenger pigeon. In the fourth year the adherents of the North-West Company and their half-breeds made serious trouble and caused no little bloodshed, and, to crown all, in the sixth year, just as the settlers were about to reap their second good harvest, there came a great plague of locusts which stripped the fields and gardens bare. It was more than even these brave men could stand; the old record says: "The unfortunate emigrants, looking up to heaven, wept." It speaks volumes for their good Scottish upbringing if they did no

more. Troubles continued; mice and floods did great damage, and not until 1830 did prosperity come; from that time on, however, the tale is one of steady and increasing progress.

Space does not allow of quotations from Prof. Buller's description of modern wheat growing in western Canada, but this is less necessary since it is more generally known than the earlier history. While it has less human interest, the tale is still a fascinating record of what can be achieved by intelligent organisation.

Another essay is devoted to the Red Fife and Marquis wheats. Red Fife was introduced into Canada some sixty years ago, and by reason of its sterling merit and great suitability to Canadian conditions it spread far and wide, doing much to make Canada's reputation as a wheat-producing country. The farmer is rarely a writer, and David Fife, who raised the first crop about the year 1842, has himself left no record of how he did it. But, though written contemporary records are lacking, oral traditions are abundant; some of them are reproduced by Prof. Buller, and they can almost be graded in point of time by their respective wealth of picturesque detail. The earliest written record is in the *Canadian Agriculturist* for March, 1861. It is there related that David Fife, of Otonabee, Ontario, in 1842 procured from a friend in Glasgow a quantity of wheat drawn from a cargo coming direct from Danzig. The wheat arrived in spring and some of it was sown forthwith; it failed to ripen, excepting only three heads, which apparently sprang from a single grain. These were preserved and the grain sown the next year; the progeny did very well, escaping rust, while all round the local wheat was badly infested. Again the grain was harvested separately, and gradually a large stock was worked up and distributed among other farmers.

The Continental origin of Red Fife was definitely established by Dr. Charles Saunders in 1904, when he proved its complete identity with a Galician spring wheat.

Dr. William Saunders, the revered first organiser of the experimental stations in Canada, whose courtly bearing and distinguished kindliness will always be remembered by those who knew him, began soon after 1886 to make crosses between Red Fife and other varieties with a view to improvement. One of the crosses actually made by his son Arthur in 1892 was between Red Fife as male and an early ripening Indian wheat, Hard Red Calcutta, as female. Unfortunately, the Indian wheat is a mixture, and the precise variety used cannot now be determined. When Dr. Saunders's second son Charles became Dominion Cerealist, he made a careful examination of the progeny of this cross, and selected from the mass of material one strain of outstanding excellence, which he called "Marquis," and which, from a single head in 1903, has spread over Canada and the United States, until in 1918 it was sown on 20,000,000 acres of land and yielded some 300,000,000 bushels of grain. So wonderful a rate of growth can scarcely have occurred before in the whole history of the world.

It is not often that a reviewer wishes a book had been longer, but that is decidedly one's feeling in closing this volume. One can only hope that Prof. Buller will find time to give us more of these delightful essays. E. J. RUSSELL.

The Fertilisation of the Ovum.

Problems of Fertilization. By Prof. Frank Rattray Lillie. (The University of Chicago Science Series.) Pp. xii + 278. (Chicago, Ill.: The University of Chicago Press; London: The Cambridge University Press, 1919.) Price 1.75 dollars net.

THE problem of fertilisation, of what really happens when the spermatozoon meets the ovum, and of how the latter is incited to begin the long series of rhythmical cleavages that finally result in a new organism, is one of the most interesting and at the same time one of the most complex in biological science. From the time of Aristotle, who held that "the female always supplies the matter, the male the power of creation," the problem has engaged the attention of biological philosophers, and no doubt it will continue to do so for generations to come, for the more it is investigated the more intricate it becomes, and each new theory, evolved under the influence of new experimental methods, is discarded in turn as our knowledge of facts increases. Not the least interesting part of Prof. Lillie's book is the historical survey with which it opens. The discovery of the spermatozoon by Leeuwenhoek and Hamm in 1677 was epoch-making for biological science, and, of course, was rendered possible only by the advent of the compound microscope. Like all other great discoveries, it was immediately followed by sensational nonsense, and we find "a certain Dr. Dalen Patius" claiming that the human body is actually visible in perfect miniature within the spermatozoon! This grotesque view, however, was but an extreme form of that held by the spermatist school in general, which maintained that the ovum plays no other part in the production of the young animal than that of furnishing the germ contained in the spermatozoon with nourishment.

The elaboration of microscopical technique in the nineteenth century, leading to the discovery of the cell, with its nucleus and chromosomes, afforded conclusive evidence that ovum and spermatozoon contribute more or less equally to the organisation of the new individual, and placed upon a secure foundation the fundamental generalisation that both are cell-units. Exactly how they co-operate in initiating development is the problem discussed by Prof. Lillie, in the light both of his own observations and of those of a small army of fellow-workers in the same field, pre-eminent amongst whom stand out the names of Hertwig, Fol, Boveri, Delage, Loeb, and E. B. Wilson.

There is one fact of fundamental importance about which all observers seem now to be agreed, and that is the twofold character of the process of normal fertilisation; not only does it stimulate the egg to develop, it also results in the combination of maternal and paternal chromosomes in the zygote nucleus. This combination is of the most far-reaching significance for the theory of heredity, but it appears to have little or nothing to do with the "activation" of the ovum which leads to development, and is only incidentally referred to in the volume before us.

As to how the activation is effected, there seem to be almost as many views as there are observers. It is well known, however, that activation can take place without the aid of a spermatozoon, and that artificial parthenogenesis may be brought about by a great variety of methods, involving the application of chemical or physical stimuli. The problem is one of physiological chemistry, and apparently many factors may be concerned in the process. The secretion of a substance by the egg which causes the spermatozoa to agglutinate and adhere to the surface, appears to be one of the most important. The formation of the so-called "fertilisation-membrane" as a result of the impact of the spermatozoon and the consequent cortical changes that take place in the ovum are fully discussed, and the hypothesis is put forward that a substance ("fertilizin") exists in the cortex which exerts a ferment-like action as it penetrates into the egg, or is carried in by the spermatozoon, and it is suggested that the spermatozoon itself requires to be "fertilised" by passing through the cortex before it can play its proper part in the events which take place internally and lead to development.

The book contains a vast amount of information as to recent discoveries and theories, and will serve as a very useful guide to those who wish to follow up this most intricate subject. A. D.

Wisdom of Life and Existence.

A Gentle Cynic: Being a Translation of the Book of Koheleth, commonly known as Ecclesiastes, stripped of Later Additions; also its Origin, Growth, and Interpretation. By Prof. Morris Jastrow, jun. Pp. 255. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 9*s.* net.

PROF. MORRIS JASTROW, jun., of the University of Pennsylvania, is well known among scholars as one of the best equipped analysts and interpreters of Biblical lore. In this volume he has taken the Book of Koheleth in its origin, growth, and interpretation, and thrown a good deal of fresh light on the subject.

In a foreword of twenty pages is given a very able sketch of the main principles of Biblical criticism and of the enormous gain which accrues from a knowledge and acceptation of them. By such means only are we able to pass from the realm of confusion to that of clearness. In our generation alone has the religious portion of mankind come to realise this necessity, and even to-day the realisation is but a portion of a small minority. Yet only by the adoption of scientific methods can the past be illumined in the realm of religion, as it has been illumined in every other field.

The author passes on to examine the origin and structure of the Book of Koheleth. Here he arrives at the conclusion that the book, as we possess it to-day, is an expanded and edited rendering of an earlier version, which, when it is viewed without the accretions, presents a gentle criticism of human life and existence. The version knows nothing of what lies behind or before us. It really deals with man's passage through life, and emphasises the present infinitely more than either the past or the future. Man is asked to make the most of the good things that Nature brings to him; he is warned not to worry about speculative things, such as his own final goal or the destiny of the universe. In spite of much that is hidden, life has a meaning here and now; it has enjoyments which make it worth while to live.

Now, it is evident that such an empirical, Epicurean view of life would never do as a *religious* interpretation of the universe or of life itself. As it stood originally, the Book of Koheleth had no chance of entering into the sacred books. It is therefore edited, added to, and polished so as to furnish here and there pious injunctions of rewards and punishments in order that the life

of the present may be lived in accordance with "ideal ends." God and the future are brought in as the norms to which life has to conform.

This portion of the book is a brilliant piece of work, and the author has brought to bear upon it not only great learning, but also a lightness of touch which really borders on something like originality. In the hands of men such as Prof. Jastrow, the Bible can again become a work of immense significance.

The next part of the book presents us with the words of Koheleth in their original form, stripped of later interpolations, sayings, and comments. The translation of Koheleth is excellent, and in reading it we seem to be brought face to face with a book published yesterday, because it looks upon the world of Nature and of life from a point of view which cannot be neglected. Of course, such aspects do not exclude others, but it is always well to make the best use of each point of view, and not to try to form a composite so vague that no meaning can be extracted from it. No doubt Prof. Jastrow had something like this in mind when he undertook the preparation of this volume, and we sincerely hope he will deal with other composite books of the Old Testament as he has done so splendidly with the Book of Koheleth.

New Books on Industrial Chemistry.

(1) *Applied Chemistry: A Practical Handbook for Students of Household Science and Public Health.* By Dr. C. Kenneth Tinkler and Helen Masters. Vol. i., *Water, Detergents, Textiles, Fuels, etc.* Pp. xii+292. (London: Crosby Lockwood and Son, 1920.) Price 12*s.* 6*d.* net.

(2) *Chemistry from the Industrial Standpoint.* By P. C. L. Thorne. (New Teaching Series.) Pp. xvi+244. (London: Hodder and Stoughton, 1919.) Price 4*s.* 6*d.* net.

(3) *Fuel, Water, and Gas Analysis for Steam Users.* By John B. C. Kershaw. Second edition, revised and enlarged. Pp. xii+201. (London: Constable and Co., Ltd., 1919.) Price 12*s.* 6*d.* net.

(4) *Popular Chemical Dictionary.* By C. T. Kingzett. Pp. vi+368. (London: Baillière, Tindall, and Cox, 1920.) Price 15*s.* net.

(1) THIS work is mainly intended for students in their third year who are preparing for diplomas in household and social science, and for diplomas and degrees in public health of the various universities. There is no work known to the reviewer that covers the ground in the same manner as this. The book is clearly and attractively written, and forms a most useful addition, not only to the academic student, but also to the works chemist, who must often adjudicate upon matters such as are dealt with in this work.

The book does not deal with manufacturing operations, but gives a clear and practical exposition (with the necessary theoretical explanations) of the methods employed in analysing and appraising the value of water, water softening processes, soap, textile fibres, bleaching agents, dry cleaning, air analysis, gaseous fuels, liquid and solid fuels, materials used in the protection of wood, metallic and other surfaces, etc. Although the authors themselves make no claim to originality, many of the subjects are treated in a manner very different from that prevailing in most of the existing works on the subject. Every technical chemist should possess a copy of this work for reference, as there is collected together here in one volume a large mass of material which is usually scattered piecemeal throughout a number of expensive treatises. Altogether this is a book to be thoroughly recommended, and it should command a wide sale.

(2) Mr. Thorne has written an interesting little book on a very large subject, which is clearly and attractively explained, and the volume marks a considerable departure from the older style of text-book. Not very long ago a book of this type would have enjoyed no sale, but would have been coldly received in scientific circles, and the advent of such a work shows what a revolution has been wrought in the chemical world within the last few years. The reviewer cannot help thinking, however, that Dr. Briscoe's excellent introduction is somewhat hard upon the business man. His own experience is that the business world is very much alive to scientific possibilities, whereas the purely professional university-trained chemist of the past was not only largely unpractical, but also held himself aloof from the problems of the business man, and the latter's caution was founded in many cases upon heavy losses attained by contact with the semi-scientific "expert," who regards the business man as his natural prey.

For the earnest technical student or the trained works chemist the book naturally is not of great use, as it cannot go into exact detail. For a young chemist, however, entering works for the first time, it gives an excellent summary of the main operations involved in chemical industry, and is well up-to-date as regards modern develop-

ments, as witness the references to rotary filters, catalytic action, hydrogenation of fats, etc.

The ordinary business man engaged in dealing with the products of chemical industry will undoubtedly derive considerable benefit from the perusal of this volume. The style is clear enough to be intelligible even to the non-technical reader.

(3) Fuel and water are such important subjects industrially that any book dealing with them is bound to receive serious attention from every works chemist and steam user. The present work (now in its second edition) meets a well-defined want in that it gives trustworthy and up-to-date technical methods of analysing fuel, water, and gas.

Part i. deals with fuel, fuel sampling, analysis of fuel, thermal values of fuel, etc., and is excellent. Part ii. deals with water as applied to technical purposes; methods of sampling and analysing it, of softening, and of calculating the amount of softening materials to be added, are given in full. Here, in a concise form, are the materials upon which a practical opinion can be formed as to the best methods of dealing with any given type of water. The subject of part iii. is waste gases, their sampling, analysis, and valuation.

The work is written by an authority who is in practical touch with the numerous and difficult problems relating to fuel and water which every works chemist has to handle. It can be recommended to every industrial chemist.

(4) The author has achieved his aim of producing a "popular" dictionary of chemistry, and the work, so far as it goes, is very complete, almost every well-known chemical or piece of chemical apparatus being briefly mentioned. It is very difficult to see, however, for what class of reader such a work is intended. For purposes of strict reference the volume is far too "popular." For example, on looking up the word "pyridine," we are informed that it is "a nitrogenous base present in bone oil, and in tar obtained from shale and coal." No mention is made of its boiling point, specific gravity, constitutional formula, solubilities, etc., which the average reader would require. This is typical of the work. In the reviewer's experience, no one looks up chemical terms for amusement. Definite *quantitative* information is what the user of a dictionary requires in ninety-nine cases out of a hundred, and it is these quantitative data which are so conspicuously lacking in the present volume. The constants of most of the materials should have been given in a work of this kind. G. M.

Our Bookshelf.

The Theory of Heat. By Prof. Thomas Preston. Third edition. Edited by J. Rogerson Cotter. Pp. xix+840. (Macmillan and Co., Ltd., 1919.) Price 25*s.* net.

IT is pleasant to meet an old friend still going strong in spite of years and changing fashions. In these days of rapid progress a quarter of a century is a long period in the life of a book dealing with a living science. The secret of the continued popularity of Preston's work is no doubt to be found in the fact that the book was written as a labour of love in the interests of true scientific education, instead of being merely compiled to suit an arbitrary standard or syllabus, adapted to a particular type of student, or a special limit of mathematical attainment. The object has been to give a comprehensive survey of the development of the theory of heat from an historical point of view, which possesses many advantages in the exposition of a scientific subject.

The historical order of evolution, both in theory and in experiment, generally follows the natural processes of reasoning of the human mind, and introduces fresh ideas in a regular sequence in which they are readily assimilated. The deductive method, starting with a general law or formula, may frequently provide a more direct means of arriving at any particular result or practical application, but it tends to obscure the essential foundation on experiment, and to rob the subject of human interest. From the point of view of the general reader, as distinguished from the special student, there can be no comparison between the two methods. There is an illusion of finality in the deductive method which appeals to the mathematical mind, but the historical method, when illustrated, as in Preston, by a critical discussion of typical experiments, is the more suggestive, inspiring the student to think for himself and to make further advances.

The book is so well known that it only remains to add that Mr. Cotter has shown himself to be a most sympathetic and capable editor in both pruning and grafting. The important additions, on recent advances in the theory of radiation and specific heat, and on the kinetic theory of gases, are admirable summaries, conceived and carried out in the spirit of the original. H. L. C.

Royal Botanic Gardens, Kew: Bulletin of Miscellaneous Information, 1919. Pp. iv+459+39. (London: H.M.S.O., 1919.) Price 4*s.* 6*d.* net.

THIS volume contains the ten numbers of the *Kew Bulletin* which were published at intervals from April to December, 1919. The thirty-three articles include papers and miscellaneous notes of both economic and strictly botanical interest. Mr. J. H. Holland contributes a useful list of food and fodder plants arranged under their respective families, with notes on their origin, uses, popular names, etc. There are also papers

on "The True Mahoganies," by Mr. R. A. Rolfe, and "The Jerusalem Artichoke," by Mr. C. C. Lacaita; the latter is an exhaustive discussion on the introduction of this vegetable to the Old World and the origin of its popular name. An account is given of Lord Ventry's experiments on growing New Zealand flax in Ireland; the evidence goes far to show that the possibility of growing it in South-West Ireland as a commercial undertaking is an established fact. "Silver-leaf Disease" and "The Skin-spot Disease of Potato-tubers" are the titles of two important contributions on plant-diseases by Messrs J. Bintner and M. Nest Owen respectively. Results of botanical exploration are embodied in Dr. Hemsley's account of the flora of Aldabra and adjacent islands and in Mr. Turrill's *résumé* of the botanical results of Swedish South American and Antarctic expeditions.

The more purely botanical papers include a careful examination, by Sir David Prain and Mr. Burkill, of the identity of the plant, or plants, known under the name *Dioscorea sativa*; and a revision by Mr. W. B. Grove of the species of the fungus genus Phoma. There is also an historical account of the botanic garden of Pamplemousses, Mauritius; and the new flagstaff at Kew and its erection are described in detail. The obituary notices include those of Prof. J. W. H. Trail of Aberdeen and Prof. W. G. Farlow of Harvard.

The Story of Milk. By J. D. Frederiksen. Pp. xx+188. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 9*s.* net.

THE author tells his story in a clear and interesting manner, and the general reader, as well as the student of domestic science or dairying, will follow the contents of the book with pleasure and profit. The subject-matter is sound, and the concise, practical directions will be valuable to anybody who is acquainted with the general methods of butter-making and cheese-making.

There are sections dealing with the composition and properties of milk, the testing of milk, the part played by enzymes and bacteria, and the methods by which organisms are utilised or controlled. Milk supply and butter-making and the manufacture of ice cream are the chief subjects of another section. As the book is written for American readers, the sixteen pages devoted to recipes for ice cream are perhaps not excessive, and they will not fail to raise in the English mind a feeling of envy that such delectable things as parfaits and mousses are not more general.

Cheese-making is well dealt with, and working details are supplied, whilst the methods adopted in the manufacture of condensed milk, milk powder, and casein are briefly sketched.

Very rightly the food value of milk is given a prominent place, and the recipes for dishes in which milk or cheese forms an important part are attractive, and should be found very useful to many. A certain amount of historical information is given, and the names and labours of notable workers in the various branches of dairying are also to be found in the book.

A First Year Physics for Junior Technical Schools. By G. W. Farmer. With an Introduction by S. C. Laws. Pp. x+183. (London: Longmans, Green, and Co., 1920.) Price 4*s.* 6*d.*

THIS book is intended for use by boys of between twelve and fourteen years of age who have just completed the elementary-school course and are passing to a more advanced curriculum such as is provided in the junior technical, central, or continuation school. It may suit the courses in some of these institutions, but if this is to be the only kind of instruction in physics during the first year of study, the diet cannot be said to be too stimulating. The work is concerned almost entirely with the use of simple measuring instruments. The description of three methods of verifying "Pythagoras," of four ways of measuring the weight of a cubic centimetre of water, and of no fewer than eleven experiments to show that air exerts pressure indicates too much devotion to completeness of detail at the expense of time which could be spent more profitably in giving the pupils glimpses at the marvels of Nature by which they are surrounded.

The Struggle in the Air, 1914–18. By Major Charles C. Turner. Pp. viii+288. (London: Edward Arnold, 1919.) Price 15*s.* net.

MAJOR TURNER gives an extremely instructive and readable account of the development of aircraft from 1914 to 1918. With the work of a generation compressed into four years of war, it is not surprising that the developments and events narrated crowd upon each other in bewildering succession. The psychology of flying and the official requirements as regards details of machines for war purposes form exceptionally valuable chapters of the book.

Calculation of Electric Conductors. By William T. Taylor. Pp. 34. (London: Constable and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

A CHART supplied with the book enables the electrical engineer to determine the size of a conductor required to convey a current of a given value when the voltage drop and length of cable are given, or to find any of these quantities when the three others are given. With the help of the explanatory text all the ordinary cables and systems can be thus dealt with.

Revision Arithmetic, Logarithms, Slide Rule, Mensuration, Specific Gravity, and Density. By Terry Thomas. Second edition, revised. Pp. 62. (London: Crosby Lockwood and Son, 1920.) Price 2*s.* 6*d.*

NUMERICAL examples and answers are given. The standard is that of the Army and Navy Entrance Examinations.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Separation of the Element Chlorine into Normal Chlorine and Meta-Chlorine, and the Positive Electron.

THE very important letter of Dr. Aston in NATURE of December 18, 1919, gives much evidence in favour of a theory of the structure and composition of the nuclei of complex atoms as published by me five years ago and in a number of more recent papers. This theory led me to the idea, as published at that time (Journal of the American Chemical Society, xxxvii., pp. 1367–96, especially pp. 1390, 1391, and 1387), that among the light elements magnesium, silicon, and chlorine, in addition to neon (as found by Thomson), are mixtures of isotopes. The atomic weights of the normal isotopes were given as 24 for magnesium, 28 for silicon, and 35 for chlorine. It was also stated that nickel, copper, zinc, and practically all the other elements between atomic numbers 28 and 80, the latter being mercury, are mixtures of isotopes; while radio-active evidence shows that elements 81 (thallium) to 92 (uranium) exist in isotopic forms. This theory was recently summarised in a paper sent to the *Physical Review* in May and November, 1919. This paper, as well as the others, should be consulted for the details of the theory.

In February, 1916, I announced that we were working in this laboratory upon the separation of chlorine into isotopes by diffusion (*ibid.*, xxxviii., p. 221, 1916). Early in 1917 Mr. W. D. Turner, my research assistant, found slight differences in density between the heavy and light fractions obtained by diffusing chlorine, but, since small amounts of impurities were very difficult to exclude, this did not seem at all conclusive. Since if there are two isotopes of chlorine there are three molecular forms of the substance, a separation may be made more easily by the use of hydrogen chloride gas, and this has been used in nearly all our work for the last three years, though practically nothing was done during the period of the war.

The diffusion of this gas, as carried out on a moderately large scale by Mr. C. E. Broeker and myself, seems now, judging by our preliminary analyses, to be resulting in a definite separation of the gas into a heavier and a lighter fraction. The separation, while extremely slow, seems from our preliminary results on the heavy fraction to be of about the order to be expected by the Rayleigh diffusion theory, provided the atomic weights of the isotopes are 35 and 37; so the work is in good agreement with that of Dr. Aston. These results may be modified somewhat when our precise atomic weight determinations are made, since at the present time all our determinations are made by rapid methods. Our results suggest, but are not of a sufficient precision really to indicate, the possibility that a third isotope of higher atomic weight may exist, but since the separation is extremely slow, and the positive ray method as worked out by Dr. Aston gives results very quickly, he should be able to test this suggestion much more rapidly than ourselves.

Since 1916 we have diffused about 19,000 litres of hydrogen chloride gas as measured under standard conditions. The apparatus now in use will diffuse about 400 litres per day, and we hope soon to raise the capacity to 1000 litres. These numbers refer to the fresh or ordinary gas introduced into the apparatus, and not to that which is rediffused in smaller units. The total number of units now in operation is five, and the method may be described as a fractional diffusion.

While the idea that the hydrogen nucleus may be the positive electron is a very general one, the only evidence I have found in print which gives real support to this idea, and explains the facts which seem opposed to the idea, is to be found in papers by my associates and myself as cited above, and in my other papers listed at the end of this letter. The hydrogen nucleus or the positive electron has, according to these papers, a weight, and presumably a mass, of 1·000, on the basis of oxygen as 16·000, whenever the positive electron is combined in a complex atom. The atomic weight of ordinary hydrogen is 1·0077. The difference between 1·0077 and 1·000 is due either to the existence of meta-hydrogen of atomic weight 3·00 and composition $(\eta_3\beta_2)+e^-$ in ordinary hydrogen, or else to an electromagnetic packing (possibly to both), the latter as assumed by Sir Ernest Rutherford and by myself, but the details of which are to be found in my papers. In these formulæ η^+ is the positive electron, β^- the negative electron when it is contained in the nucleus, and e^- when it is a non-nuclear or planetary electron.

The nuclei of atoms are built almost entirely from the following particles[1]:—

		Weight (oxygen basis)
Alpha particle or helium nucleus	$(\alpha^{++})=(\eta_4^+\beta_2^-)^{++}$	4·00
Nu particle or meta-hydrogen nucleus	$(\nu^+)=(\eta_3^+\beta_2^-)^+$	3·00
Mu particle	$(\mu)=(\eta_2^+\beta_2^-)$	2·00

Of these the α particle forms the greater part of all complex atoms; one ν particle is found in most atoms of odd atomic number, at least among the light atoms; and the μ particle, which has no net charge, is responsible for the existence of one of the two known classes of isotopes. The other class of isotopes is due to the presence of the group $\eta_4^+\beta_2^-$, which consists of an α particle, together with two cementing electrons. It is these cementing electrons which are shot off in β disintegrations of radio-atoms, and they always escape in pairs—that is, one directly after the other, or one just before and one just after the escape of an α particle. The number of *negative* electrons in the nucleus of an atom is almost always *even*, whether the nuclear charge is odd or even, but the number of *positive* electrons is nearly always *odd* in a nucleus of *odd charge*. However, the nuclei which contain an even number of positive electrons, and are therefore built up either of α particles alone or of α particles and negative electrons, are, on the whole, much more stable than those with an odd number; so the even-numbered elements are much the more abundant, and make up 98·7 per cent. of the meteorites and the greater part of the material of the earth. Furthermore, all the seven most abundant elements in the meteorites have an even atomic number, as is indicated in Fig. 1.

In the exceptional case of nitrogen the group $\eta_2\beta$ is present, and in beryllium the group $\eta\beta$. A *suggested* structure for the α particle is given in Fig. 2, where the large circles represent negative, and the small ones positive, electrons. The ν group probably has a similar structure, but with three positive electrons at the corners of a triangle; while the lithium nucleus

1 The negative electrons in these particles may be called *binding* electrons, while those which attach extra α particles are called *cementing* electrons.

is assumed to consist of one α and one ν group, with a symmetrical arrangement of the seven positive electrons. *Two α particles do not seem to combine, but from three to eight, and also ten, α particles combine without the inclusion of any cementing electrons*; but when more than ten unite, two or a

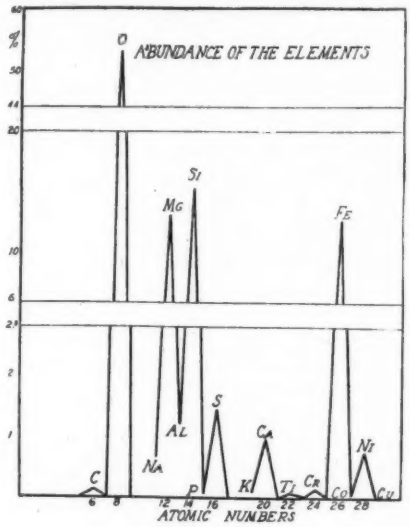

FIG. 1.

multiple of two negative electrons are used in cementing on *extra* α particles—that is, α particles which do not contribute to the positive charge on the nucleus.

Argon and calcium have *isomeric* atoms, the formula

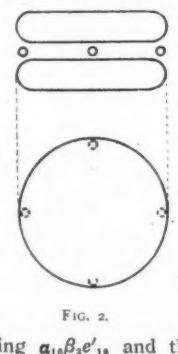

FIG. 2.

of the former being $\alpha_{16}\beta_3 e'_{18}$ and that of the latter $\alpha_{16}e'_{18}e_3$, so both have the general formula $\alpha_{16}e_{20}$. The formulæ given below represent a few characteristic atoms:—

Even Nuclear Charge		Odd Nuclear Charge	
C	$\alpha_3 e'_2 e_4$	N	$\alpha_3\eta_2\beta e'_2 e_5$
O	$\alpha_4 e'_2 e_6$	F	$\alpha_4\nu e'_2 e_7$
S	$\alpha_8 e'_{10} e_6$	Cl	$\alpha_8\nu e'_{10} e_7$ and $\alpha_8\nu\mu e'_{10} e_7$
Fe	$\alpha_{14}\beta_2 e'_{18} e_8$	Co	$\alpha_{14}\nu\beta_2 e'_{18} e_9$

Thorium Series		Uranium Series	
Th	$\alpha_{58}\beta_{26} e'_{86} e_4$	U	$\alpha_{59}\mu\beta_{26} e'_{86} e_6$
ThX	$\alpha_{56}\beta_{24} e'_{84} e_2$	Ra	$\alpha_{56}\mu\beta_{24} e'_{80} e_6$
Pb(Th)	$\alpha_{52}\beta_{22} e'_{78} e_4$	Pb(Ra)	$\alpha_{51}\mu\beta_{20} e'_{78} e_4$

Here e represents a valency electron, e' a non-nuclear electron in one of the inner shells, and β a cementing electron in the nucleus. The evidence for these formulæ is good, but cannot be presented here.

It will be seen that this hydrogen-helium-meta-hydrogen theory of atom-building is based upon the atomic weight and atomic number relations; the Rutherford atom; the rule of Soddy, Fajans, and Russell for radio-active changes; and the atomic weight relations discovered by Rydberg about thirty years ago; and is dependent for its validity upon the existence of chlorine, magnesium, silicon, and the heavy atoms in isotopic forms. It is a resurrection and an extension of the hypothesis of Prout.

References.—J. Am. Chem. Soc., xxxvii., pp. 1367–96 (1915); xxxix., pp. 856–79 (1917); *Phil. Mag.*, xxx., pp. 723–34 (1915); *Science*, N.S., xlvi., pp. 419–27, 443–48 (1917); Proc. Nat. Acad. Sciences, i., p. 276 (1915); ii., pp. 216–24 (1916); *Physical Review*, February, 1920, in press.

WILLIAM D. HARKINS.
Department of Chemistry, University of Chicago, March 8.

I HAVE read Prof. Harkins's letter with great interest. If Prof. Harkins has succeeded in separating the isotopic hydrochloric acids he is certainly to be congratulated. The very meagre positive results from my work with neon described at the British Association meeting in 1913 convinced me of the extreme difficulty and labour of such diffusion experiments. In the case of neon I had only to grapple with a twentieth root in the diffusion equation, whereas with HCl it is the thirty-sixth root which is involved. In connection with the possibility of a third isotope of chlorine in the full account of my recent analysis of this element, now in the press, I have described a faint line at 39 which may be this.

More experimental results will be required before the time is ripe for the formulation of a comprehensive theory of atomic structure. I do not propose, therefore, to discuss the one put forward by Prof. Harkins, but would like to point out that his basal assumption that the positive electron has a weight 1·000 is definitely contradicted by experimental results quoted in my letter in NATURE of March 4. F. W. ASTON.

Cavendish Laboratory, Cambridge, April 20.

On Atomic and Molecular Structure.

THE statement of Mr. S. C. Bradford in the second paragraph of his letter to NATURE of April 8, that I suppose the electrons to revolve in small circles *without any constraining force*, is erroneous. The fact that I reserved an opinion as to the nature of the constraining force does not imply, as he suggests, that I deny its existence. Thus (*cf. Science Progress*, April, 1920, and Phil. Trans. Roy. Soc., vol. ccxx., p. 247, 1920) an electron moving with speed v perpendicular to a magnetic field of intensity H (which may originate in the nucleus) describes a circular orbit of radius $\rho = mv/H\epsilon$, and the frequency of the electron is $\nu = H\epsilon/2\pi m$, which (and this is an advantage in the case of a radiating orbit) is independent of the speed with which the electron describes the orbit. At present we know little about the actual value of v. If H is of the order 10^7 gauss, the value ascribed to the molecular field from magnetic considerations, the frequency is that of infra-red radiation, and the correlation of the elastic properties of the medium (which are determined by this molecular field) with the infra-red vibrations, as originally pointed out by Debye, is apparent. Within an atom the controlling field may be of the order 10^8 gauss, which gives rise to vibrations of optical frequency. Closer to the nucleus a field of 10^9 gauss gives rise to frequencies comparable with those of a K series.

Finally, it should be pointed out that the ring electron theory, which Mr. Bradford attributes to

Dr. H. S. Allen, was originally expounded by Mr. A. L. Parson (Smithsonian Miscellaneous Collections, vol. lxv., p. 1, 1915). The advantages of such a theory were ably expressed recently by Dr. Allen in an opening address before the Physical Society of London.

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Aquarium Cultures for Biological Teaching.

THE increase in the number of students in biology during the last few years has created a demand for large quantities of such animal types as Amœba, Actinosphærium, brown Hydra, and Daphnia. It is often very difficult to obtain to time vast numbers of these types; for in Nature the supply is exceedingly precarious, depending as it does on conditions which are constantly fluctuating. In endeavouring to secure a continuous and plentiful supply of *Amœba proteus*, I have accumulated a certain amount of experience in aquarium-keeping on a large scale, the results of which will be useful to others who, like myself, have to deal with large numbers of students.

Information with regard to Amœba culture has already been given in "Notes on the Collection and Culture of *Amœba proteus* for Class Purposes" (Proc. Roy. Phys. Soc. Edin., vol. xx., part 4, p. 179). Since the publication of that note, however, I have tried, as an alternative plan for procuring the material necessary to inoculate a culture, a modification of the respective methods described by J. B. Parker ("A Method of Obtaining a Supply of Protozoa," *Science*, N.S., vol. xlii., No. 1090, p. 727, 1915), Libbie Hyman (*Journ. Exp. Zool.*, vol. xxiv., No. 1), and Asa A. Shaeffer (*ibid.*, vol. xx., No. 4), and with success.

Water from such places as the drainage-cuttings in birch, alder, and willow woods, or from the margins of ordinary pools and ponds, together with the filamentous algæ and the brown scum and included diatoms overlying the dead leaves and the other decaying organic matter forming the floor of such places, is gathered in autumn or in early spring. This is allowed to stand in tap-water for some time, until a rich brown scum appears on the top. The top water with the scum is poured off into another glass vessel, and wheat is added (1 gram to a litre of water). In February minute Amœbæ begin to make their appearance; these become fully grown in May and June, and will then divide rapidly, forming a luxuriant culture until the late autumn, when encystment of most individuals again takes place.

Once started, Amœba cultures require no further attention than a supply of water to compensate for evaporation, and the addition of wheat from time to time.

I am indebted to Prof. Bourne, of Oxford, for information that boiled rain-water can be used in those districts, *e.g.* Oxford, where the tap-water contains much mineral matter.

Actinosphaerium.—My principal difficulty in the culture of Actinosphæria has been in maintaining for them a sufficient food-supply. Stentors and vorticelloids, their favourite food, appear to require running water, and therefore quickly die off when introduced into the laboratory (except the green stentor, which thrives well when once established, and a small vorticelloid which appears in infusions of certain pond-weeds). The common rotifer is an excellent food, and this can be obtained from rubbish left over from pond-gatherings by means of wheat or hay infusion. Members of the family Cathypnadæ (especially Monostyla, which is of frequent occurrence in Amœba cultures, and therefore easily grown in wheat-water) are the most useful of the above-mentioned foods.

Since Actinosphæria disappear very quickly when their food is exhausted, and since, on the other hand, they grow and multiply very rapidly when the food-supply is good, and very quickly exhaust this food-supply, it is necessary to give the Rotifer culture a good start before introducing the Actinosphæria into it. In practice I have several Monostyla cultures in readiness, and then, about three months before requiring large numbers of Actinosphæria, I inoculate one or more of the Monostyla cultures with a few Actinosphæria and set the jar aside. These latter soon multiply and appear in myriads.

Hydra.—Large brown Hydra showing buds and reproductive organs can be obtained in considerable numbers and very quickly in laboratory cultures (especially in rooms with a fairly uniform temperature of 60° F.) if they are systematically fed on a generous diet of Crustaceans, which latter can be obtained by the culture of Daphnia. The Daphnia should be strained off by means of a small net, and a concentrated mass of them in a small quantity of water should be added periodically to the jar containing the Hydra. Several hundreds of Hydra by this means can be obtained from one or two individuals in a few weeks.

Interesting colour-changes, varying from dingy brown to a bright pink, can easily be effected in brown Hydra by varying the Crustacean diet.

Daphnia.—I am indebted to Mr. P. Jamieson for the discovery of the value of small pieces of earthworm for the cultivation of Daphnia. If an infusion of dead earthworms in water be allowed to stand in a warm place (*i.e.* near the radiators in the laboratory) it is quickly converted into a rich food, which can be added to the Daphnia cultures as required. A few Daphnia introduced into a large wide-mouthed glass bottle or beaker of water, to which the worm-water is regularly added, very quickly multiply. Several of these cultures should be kept going if the cultivation of Hydra is very intensive, as they must be allowed to recuperate after they have been depleted by use.

A variety of other Protozoa, Crustaceans, Oligochætes, etc., make their appearance in the above-mentioned cultures, commonly sufficient to supply abundant material for demonstration purposes.

MONICA TAYLOR, S.N.D.

Convent of Notre Dame, Glasgow.

Ionisation in the Solar Chromosphere.

IT is well known that the spectrum of the upper layers of the solar chromosphere is chiefly composed of those lines which are relatively more strengthened in the spark than in the arc, and which Sir Norman Lockyer originally styled enhanced lines. The best-known examples are the calcium H and K and the strontium pair (4216, 4077). According to modern theories of spectral emission, these lines are due to an atom which has lost one electron. The principal line due to the normal atom of calcium is the *g*-line 4227, and the corresponding Sr line is 4607, both of which occur at much lower levels. According to modern theories, therefore, Ca, Sr, and Ba atoms are more and more ionised as we approach the upper layers of the solar atmosphere, while in the lower layers both normal and ionised atoms occur.

If we assume that ionisation is a sort of reversible chemical process taking place according to the scheme $Ca \rightleftharpoons Ca^+ + e - U$, where e is the electron, Ca^+ is a positively charged Ca atom, and U is the energy of

ionisation, we can apply Nernst's theorem of the "reaction-isobar" to calculate the amount of ionisation under any given thermal stimulus. The method is based upon a remark of Nernst in his book, "Der Neue Wärmesatz . . ." (p. 154), that the electron may be regarded as a monatomic gas of molecular weight $\frac{1}{1836}$, and that its chemical constant can be calculated according to the Tetrode-Sackur relation

$$C=\log\frac{(2\pi m)^{\frac{3}{2}}k^{\frac{5}{2}}}{h^3}.$$

It has recently been applied by Eggert (*Ver. d. D. Phys. Gesell.*, December 15, 1919) for the calculation of the degree of ionic dissociation in the interior of a star, as supposed by Eddington in his theory of stellar structures. But Eggert calculates U in a rather artificial manner for iron from assumed atomic dimensions and structures of the iron atom.

We can, however, calculate U directly from the value of the ionisation potential as experimentally determined by Franck and Hertz, MacLennan, and others, or from the quantum relation

$$V=\frac{h\nu}{e},\ \nu=(1\cdot5,s).$$

Using the value of U determined in this way for calcium, barium, strontium, hydrogen, and helium, the following remarkable results appear:

(1) About 30–40 per cent. of the Ca atoms are ionised just over the photosphere; in the chromosphere, when the pressure falls to 10^{-4} atms., almost all the Ca atoms are ionised. The same conclusion holds to a varying degree for Ba and Sr.

(2) Hydrogen and helium are not ionised anywhere in the solar atmosphere. (This is due to their high ionisation potential. V is 13·6 for H and 20·5 for He, while for Ca, Sr, and Ba the figures are 6·12, 5·7, and 5·12.) Helium can become ionised only in stars of which the temperature exceeds 16,000 K.

(3) Pressure has a great influence on ionisation, a reduction in pressure causing great enhancement of ionisation.

It therefore appears that the ionisation in the upper layers of the solar atmosphere, as revealed by the enhanced lines of Ca, Sr, and Ba, and probably also of Fe, Ti, and Sc, is due to reduced pressure and the low ionisation potentials of these elements, and not to an increased temperature.

The full theory has been worked out in a paper communicated to the *Phil. Mag.* M. N. SAHA.

University College of Science, Calcutta,
March 8.

Gravitational Deflection of High-speed Particles.

IN a letter published in NATURE of March 11 Prof. Eddington has shown that the statement made by me in an earlier letter to the effect that Einstein's law of gravitation seems to lead to a zero deflection for a material particle moving with the velocity of light is not in accord with the exact equation of the orbit contained in his report to the Physical Society, and suggests that my approximations were not sufficiently close to warrant my conclusion. The line element from which Prof. Eddington derives the equation of the orbit is expressed in co-ordinates which make the velocity of light different in different directions at any one point, whereas the one used by me requires that the velocity of light should be a function of position only, and not of direction. In terms of my co-ordinates the equation of the orbit of a particle moving with the velocity of light is

$$u=2\frac{m}{R^2}+\frac{1}{R}\left(1-2\frac{m}{R}\right)\cos\theta,$$

which leads to the same deflection $4\frac{m}{R}$ for a material particle moving with the velocity of light as for a light-ray. Hence it is clear that my previous conclusion was based on an insufficiently close approximation, and therefore erroneous.

I am glad to see that Prof. Eddington has verified the other principal conclusion of my letter.

LEIGH PAGE.

Sloane Laboratory, Yale University, New Haven, Connecticut, March 29.

Science and the New Army.

IT requires some courage to offer any opposition to the chorus of approval which has greeted the suggestion that a proportion of officers endowed with the scientific spirit should be included in the General Staff, but I venture to think that it is by no means so easy to give effect to this proposal as some correspondents in NATURE seem to suppose. No doubt it would be delightful if we could have Staff officers who knew all about everything, but in actual practice the man who does useful work in the world is a specialist in one particular subject or in one particular branch of work.

A good regimental officer requires a particular kind of training and possesses a certain set of qualifications. Similarly, a good Staff officer requires a different training and possesses a different set of qualifications. A man of science, again, is different from either of the other two.

The proportion of officers in the Army as a whole who possess any scientific training is comparatively small. There are a certain number of specialists whose ordinary duties are of a technical nature, and there are a few officers who take up some branch of science as a hobby, but the work of the average officer is not such as to bring him into touch with scientific thought and scientific methods. Men are to be found who are good Staff or regimental officers and also scientific workers, but they are exceptions, and it seems to me that a system which demands a regular supply of exceptional men is not one which is likely to work in practice.

There is also a further difficulty. Granting, for the sake of argument, that there are sufficient officers in the Army who possess both the scientific spirit and the qualities necessary for potential Staff officers, it is still necessary to devise a method of selecting them from their more ordinary fellows. Two methods are in common use, namely, examination and nomination.

An examination is a good method of testing that form of knowledge which is acquired by study, but it will be generally agreed that it is not a good method for detecting the scientific spirit. The difficulty in the case of nomination is that the candidates must be selected by ordinary regimental officers who can alone be acquainted with the qualifications of the individual candidates. The average regimental officer, however, is not himself a man of science, and I cannot see that he can ever become a judge of another officer's scientific attainments.

Without arguing, therefore, against the desirability of a General Staff containing an appreciable proportion of scientific officers, I suggest that the ideal is unattainable except in so far as specialists are attached to the Staff for their own particular work, and I think the object in view must be attained by some other means. It might be done by raising the general standard of education in scientific matters throughout the country, but this is a very large question, and not a very easy one.

Probably the best hope of an immediate improvement in the relations between science and the Army lies in the direction suggested by Prof. Filon in his letter in NATURE of April 1, in which he says:—"I would suggest . . . that what is most urgently needed for General Staff officers is a course of scientific classification and organisation, where they would be taught the real meaning of scientific qualifications and the names of living authorities in various subjects."

The position of the Signal Service is a case in point. I think I am correct in saying that a few years before the war there was scarcely an officer outside the Signal Service itself who knew what that Service was. It was generally recognised among the officers of the Signal Service that one of their chief duties would be to advise and instruct the staff in the possibilities and limitations of the Service, and that this duty would not be less important than the supervision of the technical duties of the Service itself. This principle was applied both in manœuvres and during the war, and I think that the correctness of the views held was fully borne out by experience. The ordinary Staff officer eventually learnt that battles could not be fought without signals, and that it was necessary to take the senior signal officer into his confidence if the best results were to be obtained.

I suggest that men of science in general might well follow this example. They should realise that the Staff officer is a specialist in his own particular business and that he cannot know everything, and they should themselves advise him how science can be used and what are its limitations.

Technical and scientific societies might themselves select small committees which would be prepared to advise the War Office or other Government Departments on technical matters. The committees might also be prepared to nominate gentlemen who could visit the Staff College and other military centres and give lectures on their own special subjects. The lectures would not deal with technical matters to any great extent, but their purpose would be to show what had been done by the particular science or industry during the war, and to indicate in what directions assistance might be expected in future.

One further suggestion I should like to make. Certain sums are allotted from time to time in connection with experiments on the design of military equipment, and these funds are devoted to work which is carried out almost entirely by military officers acting under the instructions of War Office Committees. The funds now allotted are small, but I suggest that additional sums might be given for research work on military subjects which might be allotted by the War Office Committees to technical or scientific institutions outside the Army. Periodical discussions between the War Office Committees and the technical institutions with regard to these researches would tend to keep the War Office Staff in touch with leading scientific and technical workers outside, and it would permit of those personal exchanges of opinion which are worth all the official letters which were ever written.

K. E. EDGEWORTH.

Crowbbrough, April 11.

The Universities and the Army.

THE proposals contained in the leading article in NATURE of April 8, that the raw material for the commissioned ranks should be university graduates rather than public-school boys, may be ideal, but it would have been more practicable in 1914 than it is at the present day. Under the existing pressure on the universities there is rather a risk of the Army candidate being squeezed out; there is not accommodation for all candidates for commissions to enter freely. For the moment we shall have to be content with a measure by which selected officers can be accepted at universities for specialised training not readily available elsewhere. Thus the Services can obtain that contact with living science which is so essential for them, and has been so often lacking in the past. This will require supplementing by courses within the fighting Services if proper preparation is to be made for the scientific aspects of the next war. At least at the various Staff colleges trained scientific workers must lecture, while selected officers should be sent to work in university laboratories. The present state of friendly co-operation must not be allowed to disappear.

The practice of farming out research problems to scientific institutions may have favourable results if pursued in a long-sighted manner and supported by adequate grants (and, where necessary, by field or marine trials). Given close co-operation, it should lead to many problems of defence and offence being foreseen and solved in advance. The man of science should have his chance of pointing out to those who must listen (and who have the power of decisive action) what key industries are vital to the country's safety, and cannot be allowed to pass entirely to other lands. The necessary mobilisation of science at the next emergency should be quicker and more practical, and the man of science should have a better sense of the nature of the problems that are likely to be sprung upon him to solve.

One word by way of conclusion. The fighting Services are not the only national Services that would gain by a wide infusion of scientific knowledge and method.

F. J. M. STRATTON.

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Early Hawthorn Blossom.

THE first sound of the cuckoo and the first flowers of the hawthorn have come this year about the same time, which is surely a remarkable occurrence.

It is not unusual for hawthorn blossom to appear well after the beginning of May, and it has been suggested that the discontinuance of May Day festivities was due in part to the change in the calendar introduced into this country in 1752. The change made May Day eleven days earlier by the sun, and so reduced the chance of obtaining whitethorn blossom, which was the proper ornament for the top of the maypole and for the crown of the May Queen.

Gilbert White's "Naturalist's Calendar" gives April 20 as the earliest date for the unfolding of the hawthorn blossom, but the Rev. C. A. Johns in his book, "The Forest Trees of Britain," states that hawthorn blossom was gathered in Cornwall on April 18, 1846. This year it was seen on April 16 at Northwood, Middlesex.

JENNY ROSE.

The Doctor of Philosophy in England.

REFERRING to the article in NATURE of April 15 on this subject, I may perhaps recall to the recollection of the writer that in the University of Aberdeen the degree which is primarily that of Master of Arts confers specifically *Magister Artium et Doctor Philosophiae*.

HENRY O. FORBES.

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Progress in Naval Engineering.

THE association between the Royal Navy and the Institute of Metals has always been close. The first president was the late Sir William White, for many years the chief naval constructor, while the fourth to hold office was Vice-Admiral Sir Henry Oram, late Engineer-in-Chief of the Navy. The institute has now elected Vice-Admiral Sir George Goodwin as its new president, and thus for the second time chosen the Engineer-in-Chief of the Fleet as its chief executive officer.

The valuable address delivered by Sir George Goodwin on assuming office dealt very appropriately with progress in naval engineering, and the way in which this has been, and may be, still further aided by metallurgical research. As he pointed out, the British Navy is the largest individual user in the world of the principal non-ferrous metals, such as copper, zinc, lead, aluminium, nickel, tin, and their numerous alloys. The standards set by the Admiralty for most of the metals required by it have always been high, and to be on the Admiralty list in the supply of such materials has always been regarded by manufacturers as a valuable asset.

Sir George Goodwin remarked that the standing problem for naval designing engineers for the last thirty years or more has been the reduction of machinery weight and fuel consumption with increased durability and trustworthiness. There were days, however, when speed was not considered in the Navy to be of great importance, and when steam power was used chiefly for auxiliary purposes in getting in or out of harbour and in calms. In those days the machinery of warships was of very much the same type as that fitted in contemporary merchant ships. Pressure for advancement began when speed was recognised as an essential condition of naval warfare, and the never-ceasing demand since then for higher speeds has resulted not only in the enormously increased power of machinery for the swift war vessels of to-day, but also in a greatly reduced weight of machinery and an increased degree of trustworthiness.

The present-day problem, as outlined by Sir George Goodwin, deserves to be stated in his own language, and is as follows:—

> In warship design offensive and defensive powers, speed, and radius of action are all tactical factors which must be taken into account. Their relative importance varies accordingly with the type of vessel and her intended service, but in all designs, once the separate values are allocated to these features, it is essential that the weight and space required for the propelling machinery should be as small as possible consistent with maintaining the desired power and degree of reliability and durability. Anything that can be saved in this direction will react on the design of the vessel as a whole, and lead to a smaller displacement and a higher speed, or, alternatively, to reduced engine power and lower fuel consumption for the same speed; or, again, on the same displacement greater offensive or defensive powers or a larger radius of action will be rendered possible. The machinery weight is, moreover, closely allied with the steam consumption of the engines at full power, and any reduction in this respect is reflected in the weight of the boiler and condenser installation with their auxiliaries.

The position reached as a result of cumulative endeavour along these lines is that in the latest British battle-cruiser it is hoped to obtain 144,000 shaft-horse-power on a total machinery weight (including water) of 4750 tons—*i.e.* at the rate of 74 lb. per shaft-horse-power; while our most recent destroyers have frequently developed more than 28,000 shaft-horse-power on a weight of 32 lb. per shaft-horse-power.

The new president then briefly reviewed the successive steps which have led to this position. He first directed attention to the application of forced draft to naval boilers, which led by successive stages to the water-tube boiler, and pointed out that this was a time of trial with worries and troubles which have rarely had an equal. Eventually, however, the difficulties were overcome. Simultaneously with this development in boilers, we passed through a stage of intense reduction in engine weight by increasing the speed of revolution of the reciprocating engine. Following upon this came the splendid realisation of Sir Charles Parsons's endeavours for many years in the production of the steam turbine, which marked an epoch in naval engineering. It was quickly turned to account, and gave us a lead which has ever since been maintained. Another direction of progress was in respect of the fuel used for power development. For many years naval engineers had directed their attention to the utilisation of oil, but only as an auxiliary to coal. The experience obtained, however, and particularly the progress made in burning appliances, were such that it was demonstrated that oil could be used as the sole fuel when security of supply could be ensured. This done, the combination of oil fuel, water-tube boiler, and turbine became the definite policy for the Navy, and finally determined the superiority which we obtained. The British Navy was the first in the field, and its designs have been adopted in principle by other navies. The most conspicuous instance of the successful performance of the above combination was afforded by the expedition of the *Invincible* and the *Inflexible* to the Falklands in the late war and its satisfactory result.

In the second half of his address Sir George Goodwin dealt with the ways in which the work of the institute could be made to serve the advance of naval engineering, and considered briefly the problems and difficulties which centre round the use of condenser tubes, turbine blading, propeller-blade materials, bearing metals, and fast-running heavy oil engines.

Condenser tubes constitute the most important instance of the use of non-ferrous materials in the Navy. Anyone who desires to become acquainted with the perplexities of Lord Jellicoe during the late war caused by the corrosion of condenser

tubes has only to study his book entitled "The Grand Fleet." The alloy used is a tin-brass containing 1 per cent. of tin, 70 per cent. of copper, and 29 per cent. of zinc. Nearly ten years ago the institute took up this very problem with the view of solving it, and has been assisted since its inception by Sir Henry Oram and Sir George Goodwin at the Admiralty. As a result, tests are now being carried out, in one of his Majesty's vessels, of a process devised by the committee's investigators, which, it is hoped, will go a long way towards solving this particular difficulty. In its work the committee has had no better friend than Sir George Goodwin, and there is a singular appropriateness about his choice as president of the Institute of Metals. H. C. H. C.

The Investigation of Grain Pests.

By DR. A. D. IMMS.

FEW lines of biological research at the present time are of greater moment than those which are likely to contribute towards the maintenance of our food supply. Information comes from trustworthy sources that there is a considerable reduction in the available wheat of the world, and it is therefore more than ever incumbent upon us to reduce any preventable losses to a minimum. The damage sustained by stored grain through the inroads of insect pests is heavy, and we welcome a further series of the Royal Society reports [1] which are directly concerned with problems connected therewith. Prof. Dendy and his colleague, Mr. Elkington, have carried out much-needed observations of a more exact nature than has hitherto been attempted. Embodied in their reports is a good deal of both biologically and economically valuable information relating to some of our most destructive grain pests. In dealing with the phenomenon known to the trade as "webbing," they point out that it is due to the wandering of great numbers of larvæ of the moth *Ephestia elutella* over the surface of heaped grain in warehouses. Each larva trails behind itself a silken thread and, when very abundant, the whole surface of the grain may become infested with a reticulum of these threads. The superficial 12 in. of the grain are affected, and become fouled by fæcal and other larval débris. Actual injury to the grain itself does not appear to be serious, and it is probable that much of the contamination would be effectually removed during the cleaning processes to which the grain is subjected. It is, however, scarcely likely that any advantage can be derived from allowing these webs to remain, on the strength of a suggestion that weevils are destroyed through getting entangled therein. The safest and surest method is to eliminate the pest as the authors advocate, and it is noteworthy that a wide range of other food products is susceptible to the attacks of this species.

In the same report (No. 4) Prof. Dendy also deals with the occurrence of live insects in presumably sealed tins. His observations show that it is an evident fallacy to conclude that they can survive indefinitely when once the original oxygen is completely used up. The main point is to ensure that the sealing of the tins has been really efficiently carried out before the latter are relegated to the store. Directly connected with airtight storage is the question of "heating." Two experiments conducted by Prof. Dendy indicate that this process, which is due to fermentation, is prevented when the grain is stored in hermetically sealed vessels. Whether anaerobic fermentation is a factor likely to occur does not appear to have been studied. In connection with the investigations, it was noted that when a vessel is only half filled with grain attacked by *Calandra oryzae*, all the insects may become perfectly motionless in twenty-four hours. When 273·5 c.c. of air are present to 100 grains of wheat, only three insects remained alive out of thirty-nine (including all stages) at the end of fourteen days at 30°–31° C. At room temperature nineteen insects out of forty-three remained alive after thirty-two days. In both experiments the percentage of carbon dioxide had gone up to between 18 and 19, and the oxygen diminished to less than 2; and the authors express themselves as being quite certain that the insects would have succumbed soon afterwards.

It is evident from these experiments that further research under varied conditions and degrees of infestation is still desirable. If airtight storage provides ready sterilisation, without previous application of heat, we have a fact of first-rate economic significance. An important factor is the moisture content of the wheat. Above a certain point the production of carbon dioxide by wheat increases very greatly. This critical point varies with the temperature, and in the cases investigated it lies between 13·25 and 16·95 per cent. Above this critical point of moisture content wheat in airtight storage speedily renders itself immune to insect attack; below it a longer time elapses. It is noteworthy that pure (moist) carbon dioxide acts almost instantaneously as a narcotic to Calandra, but is less fatal in its effects than when mixed with a small quantity of oxygen.

The seventh report deals with points in the bionomics of *Calandra oryzae* and *granaria*, and also of *Rhizopertha dominica*, which are three of the most serious grain pests. It was found that the

1 Royal Society. Reports of the Grain Pests (War) Committee. No. 4: "On the Phenomenon known as 'Webbing' in Stored Grain." By Arthur Dendy and H. D. Elkington. "Note on the Occurrence of Live Insects in Tins supposed to be Hermetically Sealed." By Arthur Dendy. No. 5, 1919: "On the Prevention of Webbing in Wheat by means of Air-tight Storage." By Arthur Dendy and H. D. Elkington. No. 6, 1920: "Report on the Effect of Air-tight Storage upon Grain Insects," Part iii. By Arthur Dendy and H. D. Elkington. No. 7, 1920: "Report on the Vitality and Rate of Multiplication of certain Grain Pests under Various Conditions of Temperature and Moisture." By Arthur Dendy and H. D. Elkington.

optimum temperature for the breeding of Calandra is about 82° F., but somewhat higher for Rhizopertha. *C. oryzae* may increase 700-fold in sixteen weeks, which makes it a more dangerous pest than *granaria*, which has a slower rate of multiplication. On the other hand, adults of the latter species were found to survive the winter in this country at ordinary room temperature, whereas nearly all those of *oryzae* were killed off. Rhizopertha succumbs after three minutes' exposure at about 146° F., while 120°-130° F. is the lethal temperature for both species of Calandra.

As the consequence of information accumulated in the laboratory, tests along commercial lines need to be carried out in order to ascertain the practicability or otherwise of the knowledge thus obtained. We strongly urge that large-scale tests should be inaugurated with as little delay as possible. If such tests confirm the conclusion that the most satisfactory method for the storage of grain in bulk, over lengthy periods, is in air-tight silos or granaries, the Grain Pests Committee is to be congratulated upon a notable achievement. The construction of such receptacles would involve a high initial cost, but probably not excessive when the annual loss from weeviling is recounted. As the authors point out, by such a method of storage we should be provided with a means of maintaining a reserve of cereals in the event of war or crop failure, and, we may add, of economic or financial difficulties.

Some Applications of Physics to War Problems.

IN an address to the Physics Section of the American Association for the Advancement of Science, delivered at the St. Louis meeting in December last and published in *Science* for March 5, Prof. Gordon F. Hull describes the work done by a number of American mathematicians and physicists in elucidating the various problems that arose during the war in connection with long-range and anti-aircraft gunnery. It may be of interest, therefore, to record the efforts of a number of British men of science, made at a much earlier date during the war, on which (and on the work of the French) the developments of American scientific gunnery as described by Prof. Hull were largely based.

Up to the spring of 1916 the developments of British ballistic science had come largely through the Ordnance Committee at Woolwich, which during the war was fortunate in having an officer of considerable mathematical attainments as head of the ballistic office. The mass of work, however, and the extraordinary variety and difficulty of the problems that arose, especially in connection with the new science of anti-aircraft gunnery, made it necessary for the Ordnance Committee to seek help from outside; and from 1916 onwards the investigation of problems in "external ballistics" devolved largely on the Anti-aircraft Experimental Section of the Munitions Inventions Department. The A.A.E.S., as it was called, consisted of a number of mathematicians and other men of science, mainly fellows and scholars of Cambridge colleges, some from the Patent Office, one from Oxford, and three fellows of the Royal Society—some in military, some in naval, and some in civilian clothes.

The work of this group was undertaken at H.M.S. *Excellent*, Portsmouth, at Rochford Aerodrome, at the National Physical Laboratory, at University College, London, and at a variety of other places. It consisted largely of trials with anti-aircraft guns, shells, and fuses, recording the positions of shell-bursts at heights up to 33,000 ft., observing and calculating the effects of winds and of pressure and temperature abnormalities, developing the mathematical theory of ballistic calculations, and investigating the behaviour or the causes of failure and irregularity of fuses. In addition to this, work of considerable mathematical and physical interest was done, some of which will be published, on the general dynamics of shell flight (such problems as the stability of shells, the effects of rotation of the earth, "drift," the "twisted trajectory of the shot," etc.), and on the pressure distribution on the head of a shell in flight. The solution of some of these problems, undertaken originally in connection with anti-aircraft gunnery, had, in the end, a considerable bearing upon the theory of gunnery in general.

The A.A.E.S., in addition to its main work in investigating the problems of gunnery, did a large amount of routine computing of range tables in conjunction with the staff of the Galton Laboratory, and performed a number of interesting and important trials on time-fuses in co-operation with the Engineering Department of University College, London. It carried out far-reaching experiments on the use of sound-locators for the detection of aircraft, and in conjunction with the R.E. and the Air Force on the co-operation between such sound-locators and searchlights; the military equipment and methods finally adopted were based directly on these experiments. It tested both the theory and the use of a number of instruments required for anti-aircraft work, such, for example, as range-finders, height-finders, and "predictors" (instruments for predicting the "future position" of the target at the moment the shell bursts); and finally it had what was known familiarly as a "travelling circus," which moved about in Great Britain and France recording the results of practice anti-aircraft shoots, and investigating the performance of guns and instruments.

The work terminated in April, 1919, and an interesting body of scientific workers was disembodied, disbanded, or demobilised. The more important practical results of their work are being recorded for the use of the military authorities: the methods adopted, however, and many of the observations, calculations, and speculations, the personalities of the men themselves, their various homes and adventures, the help (and the hindrance) they received from various people and officials, would provide material for a fascinating history of some "applications of physics to war problems"—a history, however, which will probably never be written.

Obituary.

PROF. J. A. MCCLELLAND, F.R.S.

JOHN ALEXANDER McCLELLAND was born at Coleraine in 1870. Leaving the High School, he studied in University (then Queen's) College, Galway, and after a distinguished course he obtained a junior fellowship of the Royal University. Proceeding to Trinity College, Cambridge, he worked under Sir J. J. Thomson, and was one of the brilliant band of investigators who made history in those days in the Cavendish Laboratory, being contemporary with Sir Ernest Rutherford, Prof. Townsend, and others. In succession to the late Prof. Preston he became professor of experimental physics in University College, Dublin, and quickly began his famous researches on secondary radio-activity.

Shortly after becoming a fellow of the Royal Society, the National University was founded, and McClelland was appointed a member of the senate and of the governing body of University College, Dublin, positions which he held until his death. He at once devoted himself to the planning of the physical laboratory of the college. His efforts were highly successful, and a very efficient research department quickly sprang up, which accomplished wonders, considering the resources at its disposal. The number of students in the college in the beginning was 550, and at the present moment it is 1350, and the task of keeping pace with such rapid growth might easily have absorbed all the time of a lesser man; but McClelland had many other spheres of activity—secretary to the Royal Irish Academy, member of the Board of National Education, member of the council of the Royal Dublin Society, and governor of St. Andrew's College—yet he undertook a still more onerous task. He became a member of the Privy Council Committee on Scientific and Industrial Research, which necessitated frequent journeys from Dublin to London, and this during the war, when, apart from the great discomforts of travelling in those times, every crossing of the Irish Sea was a gamble with death. The constant strain was too much for him, and oftentimes his friends urged him to take a long rest. His sense of duty, however, prevented him from paying attention to his bodily weakness, and when at last the college authorities persuaded him to take a six months' rest, it was too late.

As a man of science the outlook of McClelland and his method of exposition had all the clarity of Faraday. Although, unlike Faraday, he had a sound mathematical training, his mind worked in the direction of a "common-sense" explanation of the most complicated phenomena. This made him especially valuable as a teacher, whether for advanced or elementary work. It has been the privilege of the writer to sit with him on many boards, and this same faculty of cutting away the unessentials of a question, and presenting it in its reality, rendered him a valued colleague in many matters far removed from the world of science. A Presbyterian in religion, he was followed to his grave by men of every shade of thought. It is a commonplace almost devoid of meaning to speak of a loss as irreparable, but in his college and in the wider public life of Ireland everyone who knew him feels that a man has gone from amongst us whose place it will be impossible to fill. A. W. C.

DR. J. G. BARTHOLOMEW.

GEOGRAPHERS throughout the world will recognise that scientific geography has sustained a grave loss through the death suddenly at Cintra about midnight on April 13 of Dr. Bartholomew, the head of the cartographical firm which has been known since 1889 as the Edinburgh Geographical Institute.

Dr. Bartholomew was a native of Edinburgh, where he was born on March 22, 1860, and where he was educated at the High School and the University. As a young man he entered the business founded by his grandfather. From the age of twenty-two he took an active part in its management, and at twenty-nine he succeeded his father in the supreme control. By this time he had devised the method of representing topographical features by the system known as layering, which has made the Edinburgh Geographical Institute celebrated throughout the world, and is now copied in all other cartographical establishments. Like many other novel ideas, it may seem very obvious once it has been introduced. It merely consists in the spreading of distinctive colours, tints, or shades between successive contours on a contoured map. It accordingly gives no information as to the physical features additional to that furnished by the contours; but it

makes that information available at a glance, and hence, simple as the device is, its introduction had a revolutionary effect in cartography, all the more so because it is found capable, like contouring generally, of being combined with other methods of representing physical features.

The first important work issued by the institute illustrating this new system was "The Survey Atlas of Scotland," first published in 1895, which was followed in 1903 by a similar atlas of England and Wales. Previously to that Dr. Bartholomew had published (1899) "The Atlas of Meteorology," a work of immense labour with several original features, which shows even more strikingly his zeal for scientific geography, and amply justifies the motto he had adopted, "Amore et labore." It came out as vol. iii. of a great atlas of physical geography which he had designed, but of which only one other volume appeared during his life, "The Atlas of Zoogeography," published in 1911. Much of the most devoted work of his latter years was given to the preparation of the atlas (reviewed in these columns a few weeks ago) now being published under the title of "The *Times* Survey Atlas of the World," by which he hoped to outrival the best works of the kind published in other countries.

But the Geographical Institute was far from engrossing all Dr. Bartholomew's interests. He was a member of council of the Royal Society of Edinburgh from 1909 to 1912, but in Edinburgh he was, above all, known through his intimate association with the Royal Scottish Geographical Society, of which he might with little exaggeration be called the founder. From him, at any rate, came the first suggestion of such a society, and he was among the most eager of that small body of men who in 1884 spent without stint time, energy, and enthusiasm in getting it established. He was an honorary secretary of the society from the first, and remained so until his death. By the council of that society he was generally regarded as its mainstay and chief directing spirit, and nowhere outside his family will his loss be more keenly felt than on that board.

Dr. Bartholomew was an honorary member of many foreign geographical societies. The Victoria Research Medal, a medal not awarded regularly every year, but only when there is a fit recipient, was conferred upon him by the Royal Geographical Society in 1905 "for his successful efforts to raise the standard of cartography"; and in 1918 the Helen Culver gold medal was awarded to him on like grounds by the Geographic Society of Chicago. In 1909 he received from his own university the honorary degree of LL.D. In private life he was held by all who knew him in the highest esteem, and as revealing his nature nothing, perhaps, could be mentioned more characteristic than that, in spite of the fact that he lost a son in the war, he was able to speak even of enemy countries with rare magnanimity.

GEO. G. CHISHOLM.

WE much regret to announce the death on April 18, in his seventy-third year, of DR. RUDOLPH MESSEL, F.R.S., president of the Society of Chemical Industry and past vice-president of the Chemical Society.

WE notice with regret the announcement of the death, very suddenly, on April 17, of PROF. A. K. HUNTINGTON, emeritus professor of metallurgy at King's College, London.

WE regret to record the death on April 18 of PROF. L. T. O'SHEA, professor of applied chemistry in the University of Sheffield and honorary secretary of the Institution of Mining Engineers.

MR. JAMES GAYLEY, whose death was recently announced, was the first vice-president of the United States Steel Corporation and made many important contributions to the progress of metallurgical industry. He was president in 1904–6 of the American Institute of Mining and Metallurgy and had been a member of the Iron and Steel Institute since 1888. The honorary degree of B.Sc. was conferred on him in 1912 by the University of Pennsylvania and Lehigh University; in 1906 he was awarded the Elliott Cresson medal, and in 1913 the Perkin medal, by the Franklin Institute.

MR. WILSON WORSDELL, whose death on April 14 is recorded in the *Engineer*, was born at Crewe in 1850, was educated at Ackworth, and served a pupilage in the Altoona Locomotive Works of the Pennsylvania Railroad. On returning to this country Mr. Worsdell took up an appointment with the London and North-Western Railway, and in 1883 became assistant locomotive superintendent to the North-Eastern Railway; in 1890 he was appointed chief mechanical engineer of the same railway. Up to the time of his retirement in 1910 he supervised the construction of more than 1000 engines for the North-Eastern Railway.

THE death of SIR CHARLES ALLEN on April 13 is recorded in *Engineering*. Sir Charles was born in 1851 and educated at Halifax and at a technical college in Germany. In 1872 he entered the Bessemer works at Sheffield, of which his father, who was a brother-in-law of Sir Henry Bessemer, became chairman in 1889. He succeeded to the chairmanship on the death of his father in 1899, and the remarkable success of the company, especially in later years, is due largely to his ability. Sir Charles recognised fully the value of metallurgical research, and gave every encouragement in the developments of this branch; he was closely identified with the foundation of the Bessemer laboratory at the Imperial College of Science and Technology.

Notes.

NEWS of Capt. Roald Amundsen's Arctic Expedition has unexpectedly been received from Siberia *via* Alaska. The *Maud* left Norway in June, 1918, and was last heard of some months later from Dickson Island, at the mouth of the Yenisei. According to the telegram published in the *Times*, two men left the ship in October, 1918, in the vicinity of Cape Chelyuskin. Nothing has been heard of these men, although they presumably made for the fishing settlements of the Lower Yenisei, a distance of some six or seven hundred miles across the barren tundra. There seems to be little hope that the two men are alive. The *Maud* appears to have spent last winter in the neighbourhood of Aion Island, at the mouth of Chaun Bay, in north-eastern Siberia, within six hundred miles of Bering Strait. Aion Island is noted for its reindeer pasture. The coast in the vicinity is visited by native and occasional American traders in summer. The distance to the nearest wireless station at the mouth of the Anadir is about 450 miles across rough country. Until further news arrives it would be rash to suppose that Amundsen has abandoned his trans-polar drift. It is quite possible that he intends to push into the Arctic basin north of Bering Strait in order to ensure the drift taking him to a high latitude. On the other hand, the loss of two men, even supposing his messengers to the Anadir return, will seriously weaken his expedition. Capt. Amundsen always maintained that his aims were scientific, and that he had no desire merely to reach the North Pole. It is not, therefore, probable that he will return this year, since the coast of Siberia along which the *Maud* has sailed has been explored in recent years by Russian expeditions. The *Maud* is provisioned for another three years.

THE United States National Research Council has appointed a committee on eugenics, under the Division of Biology and Agriculture, consisting of the following members:—L. F. Barker, A. G. Bell, E. A. Hooton, Daniel W. LaRue, Stewart Paton, Raymond Pearl, R. M. Yerkes, H. S. Jennings, and C. B. Davenport (chairman). The committee met on Saturday, March 20, and decided to hold the second International Eugenics Congress in New York City on September 22–28, 1921, inclusive. Dr. Alexander Graham Bell was elected honorary president, Dr. Henry F. Osborn president, Mr. Madison Grant treasurer, and Mrs. Sybil Gotto, secretary of the Eugenics Education Society, in view of her activity in organising the first Eugenics Congress, was nominated honorary secretary of the second Eugenics Congress. The national consultative eugenics bodies in the various countries will be informed of the action of the eugenics committee of the National Research Council and invited to send representatives. A general invitation will be sent to universities in different American countries and in the countries of Europe.

THE president, vice-president, and council of the Royal College of Surgeons in Ireland have elected Prof. G. Elliot Smith to the Mary Louisa Prentice Montgomery lectureship in ophthalmology. The subject of Prof. Smith's first lecture will be "The Influence of Stereoscopic Vision on the Evolution of Man." The lecture will be delivered in October next.

AN extraordinary general meeting of the fellows of the Chemical Society will be held at Burlington House on Thursday, April 29, at 5 p.m., to consider the alterations in the by-laws proposed by the council.

THE reorganisation and co-operation of research departments contemplated at the Middlesex Hospital promise to be of great value. In particular the co-operation of such distinguished investigators as Profs. Swale Vincent and McIntosh with Prof. Russ and Dr. Lazarus-Barlow may be expected to direct the investigations of cancer on the broad and general lines so necessary at the present time in this subject. We wish the new arrangements every success.

THE Report of the Salisbury Public Library for 1919–20 describes the arrangements for advancing adult education by means of a series of public lectures. A course of eight lectures was delivered by Mr. F. Stevens on the history of the neighbourhood at various periods. The lectures fell into two groups of four each, prehistoric and early historic, and were illustrated from the collections in the city museum by an inspection of the actual objects and by some five hundred photographs. The course, of which a syllabus is appended, attracted good audiences, and was so financially successful that a substantial balance remains, which is being expended in strengthening the existing collection in the library of books on Wiltshire. The committee may be congratulated on this result, and other public libraries throughout the country may use the report as a suggestion for similar arrangements.

DR. FELIX OSWALD and Mr. T. D. Price announce for publication at an early date a book entitled "An Introduction to the Study of Terra Sigillata, Treated from a Chronological Standpoint." During their excavations at the Roman station of Margidunum, in Nottinghamshire, the authors were impressed by the difficulties inherent in the study of Terra Sigillata, the so-called Samian ware, and especially by the necessity for collecting the many scattered references to the subject in many languages besides English. The importance of the study lies in the historical evidence furnished by this ware, for, apart from inscriptions, no relic of the Imperial age is more important for chronological purposes. Ample materials for the investigation are provided at sites such as Haltern, Hofheim, Newstead, and Niederbieber, which can be dated by historical evidence and from the names of the potters inscribed on their work. As the Gaulish Sigillata is a development of the Italian or Arretine fabric, a short account of this is supplied. The book promises to be valuable for the study of the Roman period in Western Europe.

IN an account of the Apalaii Indians of the Amazon (*Museum Journal*, vol. x., No. 3, September, 1919). Mr. W. C. Farabee describes a remarkable form of puberty ordeal. A frame in the shape of a jaguar, possibly an indication of totemism, is made of wicker-

work, and about a hundred wasps or ants are passed through the interstices. The youths, exhausted by a dance which is kept up all day, present themselves before the medicine-man, who applies the wasp-frame to their chests, backs, arms, and legs. Those who scream or show signs of suffering when they are stung are not allowed to continue the ordeal. Those who pass the test are invested with a headdress and flute, and deemed fit for marriage. But more than this is required. The youth must give proof that he is able to support a family by passing the target test of throwing cassava pellets at a circle drawn on a piece of wood, and of shooting arrows from a rapidly moving boat. Girls undergo the ordeal of fasting in seclusion, and their bodies are scarified with the sharp teeth of an animal or fish. They are then dressed in aprons, and use charms to stimulate affection in courtship, in which they take the initiative.

DR. A. M. BLACKMAN discusses in the Journal of the Manchester Egyptian and Oriental Society for 1918–19, recently issued, "The House of the Morning" in Egyptian ritual. The Heliopolitan sun-god Re-Atum was represented by his priests as re-born every morning as the result of his undergoing lustration, which was supposed to be performed by the sun-god himself, assisted by other divinities. The king of Heliopolis, high priest of the sun-god, was regarded as his son and embodiment. The lustral washing of the king-priest took place before he officiated in the sun temple, and as a result of it he was thought to be re-born like his divine prototype. His purification was completed by fumigating him with incense and presenting him with balls of natron to chew. "By being washed or sprinkled with holy water and fumigated with incense, and by the chewing of natron, the king was mysteriously re-born, brought into contact with divinities, and imbued with their unearthly qualities, and his mouth made fit to chant the sun-god's praises and recite the formulæ which accompanied the enactment of the various episodes composing the daily service in the sun temple."

IT is well known that in ancient India, as described in the Institutions of Manu, the law-giver, marriage was permitted between members of different castes—a system which was forbidden by later Brahmanical legislation. Mr. Patel, one of the advanced Indian members of the Viceroy's Council, recently introduced a Bill providing that marriages between Hindus of different castes shall be valid. More conservative members opposed the Bill on the grounds that it would undermine the present social system, and that it was opposed to Hindu custom, the potent force which controls Hindu society. It was also pointed out that the enactment of such a law raised the wide questions connected with succession, adoption, and legitimacy, for which no legislation was provided in the Bill. The Government representative, Sir W. Vincent, adopted a neutral attitude, admitting that the question should be decided by public opinion carefully devoted to its consideration. If the Bill is finally passed it will be a serious blow to caste, but it is significant of the general feeling that the Mohammedan members refused to sit on the Special Committee appointed to consider it on the grounds that the question was one for Hindus, and that the latter had been obstructive on the grant of communal representation for Dacca University.

THE history of science is rapidly acquiring its own periodical literature. Dr. Sarton in a recent issue of *Isis* set forth a bibliography of reviews and collections on this subject, of which he recognised sixty-two. Most of these deal with special sciences, among which mathematics and medicine take first place. Several journals are, however, devoted to the history of science as a whole. The earliest was the *Archiv für Geschichte der Naturwissenschaften*, which has appeared since 1908. Next came *Isis*, the publication of which was interrupted by the war; it has now recommenced, and will in future be in English and under the joint editorship of Dr. Sarton and Dr. Singer. The Italians have now also started a quarterly, *Archivio di Storia della Scienza*. It is edited by Prof. Aldo Mieli, who has long devoted himself exclusively to the history of science, and has printed the first volume of a monumental work on the subject. It is encouraging to historians of science that his enthusiasm has overcome the economic and social difficulties that prevail in his country, and that the publication of the *Archivio*, begun in March, 1919, is now being continued. In addition to original articles on every aspect of the history of science, it will contain reviews, a bibliography of Italian works on the subject, and notices on activities in connection with it, which are very pronounced in Italian universities. The annual subscription to the *Archivio* is 35 lire, and it should be sent to Attilio Nardecchia, Via dell' Umiltà 14, Roma 19. Information concerning *Isis* can be had from Dr. George Sarton, Carnegie Institution, Washington, D.C., U.S.A., or from Dr. Charles Singer, Westbury Lodge, Norham Road, Oxford.

MISSES BLACKLOCK and Carter contribute to the *Annals of Tropical Medicine and Parasitology* (vol. xiii., No. 4, March, 1920) papers on a mosquito, *Anopheles plumbeus*. The bionomics of this species are probably less known than those of any European Anopheline mosquito. The species is widely distributed, being met with in the British Isles, in nearly all European countries, and in the Western Himalayas, and is essentially a tree-hole breeder. Experimental evidence is produced for the first time that *A. plumbeus* is capable of becoming infected with a malaria parasite, and may therefore transmit malaria.

A SUGGESTIVE review of the pathology and symptomatology of beri-beri is contributed by Dr. F. M. R. Walshe to *Medical Science: Abstracts and Reviews* (vol. ii., No. 1, April, 1920). The current hypothesis of the nature of beri-beri (a disease particularly of the East characterised by the development of neuritis) is that it is a "deficiency disease," due to the lack of certain elements or "vitamines" from the food. Dr. Walshe points out that the neuritis of beri-beri is similar to that produced by certain poisons, such as

alcohol and the diphtheria poison, and that neurologically we are dealing with no negative or defect disease, but with a definite, positive reaction of the nervous system to some unknown poison. "We know nothing of what happens in the body from the eating of a vitamine-free diet to the moment when the symptoms of beri-beri appear, and we cannot exclude the possibility that such a poison has been produced in the body." Dr. Walshe seems to agree with Eijkman that the ultimate cause of beri-beri may yet prove to be a nerve poison produced by a disordered metabolism arising out of vitamine deprivation.

A "FLORA of the District of Columbia and Vicinity," by A. S. Hitchcock and P. C. Standley, with the assistance of other Washington botanists, has been issued as vol. xxi. of Contributions from the United States National Herbarium (329 pp., 42 plates). It will replace Lester Ward's "Guide to the Flora of Washington and Vicinity," published in 1881, to which there have been six supplements. The area included is approximately a circle of fifteen miles radius, with the Capitol as the centre. The list includes all indigenous plants and all introduced ones that have become established; chance introductions are mentioned in notes appended to an allied species or genus. It is interesting to note that parts of this area are still almost wholly unexplored botanically, and the publication of the flora will afford an excellent opportunity for local botanists to supply the gaps. The arrangement is in the form of keys to the families, genera, and species, which have been carefully worked out, and also tested in the field during one collecting season; and the text is clear. An effort has been made to use common words so far as possible as substitutes for technical terms, and so-called popular names are provided for most species in the manner familiar to British botanists in Bentham's "Handbook." The Old World botanist will find some familiar plants hidden under strange names, as, for instance, Dicentra and Negundo (box-elder), which appear as Bikukulla and Rulac. The plates are a series of good photographic reproductions of aspects of the vegetation and of some of the commoner species. Unfortunately, the size of the book, large octavo, militates against its use as a pocket companion for the field botanist.

MR. J. F. N. GREEN (Proc. Geol. Assoc., vol. xxx., p. 153, 1919) has treated in his presidential address to the Geologists' Association the vulcanicity of the Lake District from a natural history point of view. He illustrates the use of petrographic details as a means of realising the conditions of intrusion and eruption, as when he pictures the scoria-cones of Borrowdale age rising above the sea and contributing their materials to the sediments by ordinary processes of erosion. He urges that the chemical analysis of an igneous rock is by itself of little value, since it cannot take into account the evanescent constituents of the magma.

FORAMINIFERA as a group always have their fascination owing to their irresolvable simplicity of organic structure and their apparent powers of selection in the up-building of their coverings. Mr. J. A. Cushman (Proc. U.S. Nat. Museum, vol. lvi., p. 593, 1919) describes "Recent Foraminifera from off New Zealand," including a new species of Technitella, a genus that forms its test of neatly arranged acicular sponge-spicules. In Bulletin 676 of the U.S. Geological Survey the same author describes Pliocene and Miocene species from the coastal plain of the United States, and shows how they help to indicate former marine climatic conditions. Mr. Cushman's wide knowledge of recent Atlantic forms renders even brief notes of this kind suggestive to the geologist.

REFERENCE has been made in NATURE (vol. xcv., p. 216) to the replacement of quartz by pyrite. A very remarkable case is now put forward by Mr. W. H. Collins in the Summary Report of the Canadian Geological Survey for 1918 (part E, p. 20, 1919) from the Michipicoten district of Ontario. The basement beds of stratified sands and gravels belonging to the Pleistocene drift, and resting on the Keewatin iron-bearing series, have apparently been replaced by "snow-white granular silica" (presumably quartz) with a deposit of loose pyrite grains below resembling ordinary sand, and sometimes 5 ft. thick. Mr. Carus-Wilson, it may be remembered, has cited a case of the replacement by pyrite of the carbonaceous cement of an Eocene sandstone (NATURE, vol. lxviii., p. 436); but in the Canadian instance the sand-grains themselves have disappeared under the influence of solutions draining along the unconformable junction from the adjacent iron range.

THE Summary Report of the Mines Branch of the Department of Mines of Canada for the year 1918 has just been issued, and contains an interesting record of the year's activities. The fuel-testing station has been engaged, in addition to its regular routine work, upon an investigation on the carbonisation and briquetting of lignite, which promises to yield important results, as also does a test of New Brunswick oil shale in a novel type of retort—the Wallace retort. The methods adopted in Canada may be studied with advantage by those engaged in the study of carbonisation problems in this country. Good work is also being done in the ore-dressing division; until the middle of the year this had been engaged on the production of molybdenite concentrates on a working scale in view of the Empire's requirements of ferro-molybdenum for war purposes; afterwards, however, the normal working of the division was resumed and a variety of ores was tested and reported upon, the methods used being not only the ordinary wet-dressing methods, but also flotation (in a Callow cell), magnetic separation, electrostatic separation, and cyanidation. The Mines Branch may fairly be congratulated upon an excellent year's work, which must form a powerful factor in the development of the mineral resources of the Dominion.

IN the March issue of the *Decimal Educator*, a quarterly publication of the Decimal Association, there is an interesting historical account of the International Bureau of Weights and Measures at Sèvres, the establishment at which the international prototypes of the metre and the kilogram are preserved.

It is pointed out that the investigations at the Bureau have led to a vast improvement in the constancy and trustworthiness of thermometers and in the measurement of atmospheric pressure, and it is proposed to describe in future issues the instrumental equipment of the Bureau and the metrological work undertaken there. A good portrait is given of Dr. Guillaume, the director of the Bureau, who is to deliver the Guthrie lecture to the Physical Society to-morrow, April 23. In an article on the metric system it is urged that, in addition to teaching the system in schools, the Government should set a lead by adopting it in Departments such as the Post Office, the Ministry of Health, and the Royal Air Force, thus familiarising the public with metric measures and preparing the way for a change which is inevitable. Another feature of the number is an explanation of the advantages of decimal coinage.

A SUMMARY of the weather for the year 1919 has recently been issued by the Meteorological Office. It deals very fully with the annual results of the several elements for numerous representative stations for the several districts of the British Isles. The year was generally dry, and was noteworthy for the heavy snowstorm on April 27–28, and for the exceptionally cold March and November. October, which is normally the wettest month of the year, was in many places the driest. The mean temperature for the year was below the normal in all districts, the deficiency ranging from 1·6° F. in East Scotland to 0·4° F. in the south of Ireland. The earth temperatures were also below the normal, both at 1 ft. and 4 ft. below the surface. Rainfall was in excess in the eastern districts and deficient in the western districts. Sunshine was mostly in excess of the normal except in some of the eastern districts. Data are given showing the warmest day and warmest night, also the coldest day and coldest night, for the several stations of the different districts, and there are similar details for the several months. Monthly frequencies of sunshine for selected stations are shown. Days in the year with rainfall between fixed limits are given for selected stations, and the number of days in the year with certain maximum and minimum temperatures. Many and various particulars of anemograph observations are given, with the frequency of hours with average wind speed, also with a maximum hourly speed. A table shows the frequency of winds of various strengths from different directions for several stations in different parts of the British Isles. Much of the data is in a form which will be available for aviation requirements.

THE February and March issues of the Journal of the Franklin Institute contain the report of the committee—consisting of Messrs. E. P. Hyde, P. W. Cobb, H. M. Johnson, and W. Weniger—of the Nela Research Laboratory which undertook the investigation of the relative merits of monocular and binocular field-glasses under Service conditions. The tests are not yet completed, but already afford a large amount of valuable information. The principal conclusions of the eighty pages of the report are that in the hands of not very experienced observers the monocular requires to have a magnification of 6·27 in order to give the same results as a binocular of the usual magnification of 6·0. As regards rapidity of production and adjustment, cost, weight, portability, and ease in use the monocular is far ahead of the binocular. The report deserves careful consideration by optical-instrument makers in this country.

IN an article in the April issue of *Science Progress* Major A. E. Oxley summarises his work on the magnetic properties of about forty organic compounds between −180° and 200° C., and shows that atomic theories of the Rutherford-Bohr type, which neglect magnetic forces, are incapable of accounting for many of the magnetic properties of matter. How these theories are to be modified he is not yet in a position to say, but his diagram of two atoms held together by electromagnetic forces shows these forces to be due to a pair of oppositely directed circular currents in each atom outside the positive nucleus and rotating electrons. This idea is on the same lines as those put forward recently by Parsons (1915) and Langmuir (1919). The author points out finally that an adequate theory must account for the molecular structure of crystals, and the relations between that structure and their behaviour in the magnetic field must agree with stereochemistry, give the additive property of diamagnetics, and show no dielectric hysteresis. It is to be hoped that the forthcoming discussion on the subject of atomic structure at the Royal Society will throw some light on these difficulties of present theories.

AN important paper on the magnetic characteristics of the iron core of a transformer or of an induction coil by the late Prof. B. Osgood Peirce is published in the Proceedings of the American Academy of Arts and Sciences (vol. l., No. 7, p. 149). Sixty years ago Helmholtz verified the predictions of the mathematical theory of a transformer. The verification, however, was limited to the case when the inductances of the two coils were constant. With an iron core—the case considered by the author—this assumption is not justified. He first tried the loading coils which are used in long-distance telephony. The cores of these coils are made of iron wire only one-tenth of a millimetre in diameter. The eddy currents induced in the core are therefore negligibly small. Assuming merely the connection between the ampere-turns and the magnetisation and Faraday's law for the electromotive force induced by a change in the magnetic induction, Prof. Peirce found that the experimental results agreed with those deduced from theory to within about the tenth part of 1 per cent., *i.e.* to within the limits of experimental error. Even with the ordinary closed iron circuit commercial transformer he found that the predictions of theory were verified to high accuracy when the eddy currents in the core could be neglected. It was concluded that a good approximation to the shape of the current curves, to the rate of growth of the excitation, and to the flux of the magnetic induction in the core of a transformer can be obtained when an accurate statical hysteresis diagram of the core over the given range is available.

Our Astronomical Column.

OCCULTATION OF A STAR BY SATURN.—Bad weather prevailed generally in Europe on March 14, when Saturn occulted the star Leipzig I 4091, mag. 7·6. A few observations were, however, secured, some of them being published in *Astr. Nach.*, 5042. Prof. Plassmann observed the disappearance at Münster, noting that at 7h. 3·0m. G.M.T. the star was still separated from the limb, at 7h. 5·1m. it was in contact with it, while at 7h. 5·9m. the star had disappeared.

Messrs. K. Novak and V. Rolcik, observing at Smichow, long. oh. 57m. 38s. E. Gr., lat. 50° 4′ 42″ N., noted the reappearance at 8h. 39m. 40s. G.M.T.

Dr. Bernewitz, at Berlin-Babelsberg Observatory, first saw the star at 8h. 39m. 34s. G.M.T. He noted that at 8h. 39m. 51s. it appeared of full brightness, and at 8h. 40m. 5s. the centre of its disc was distinctly separated from the limb. He states that the marked red colour of the star made it easy to distinguish its light from that of the planet. He made the only observation so far to hand of the appulse of Titan to the star, which occurred some four hours after emersion from the planet. He states that Titan did not occult it, but passed 1″ or 2″ to the north of it.

The extreme accuracy of Mr. Burnet's prediction is noteworthy. He gave 7h. 5m. for the disappearance, and 8h. 40m. for the reappearance. Owing to the slowness of Saturn's motion, he thought it likely that these times would be in error by several minutes.

THE EINSTEIN DISPLACEMENT OF SPECTRAL LINES.—The *Observatory* for April contains communications on this subject by Messrs. J. Evershed and C. E. St. John. The former gives reasons for thinking that the pressure in the photosphere is extremely low, so that pressure may be eliminated as a disturbing factor. Using forty-two iron lines, selected as not subject to pole effect, he obtains a shift equivalent to a recession of 0·643 km./sec. at the sun's centre and 1·000 at the limb. But observations of Venus at various elongations support the idea that this is not an Einstein effect, but a shift of all regions of the sun away from the earth. It is remarked that it is difficult to accept this as a physical reality, but no other explanation has yet been found. He notes that some of the carbon lines give an effect similar to the iron ones, but somewhat smaller. The effect seems to vary for different substances, and even for different lines of the same substance, so that some modifying influence is at work.

Mr. St. John recapitulates his well-known investigation, in which he used certain lines of the cyanogen band; he then describes his recent work on magnesium and iron lines. He finds from their weighted mean a displacement of the same sign as the Einstein prediction, but of only one-third or one-fourth of its amount. Mr. St. John notes, however, that the displacement varies with the intensity of the lines, being greatest for lines either of very great or very small intensity. As the majority of the lines measured are of medium intensity, the weighted mean is reduced. He also notes that no lines have been used which seemed unsuitable for the purpose, owing either to their proximity to others or to their instability in the arc spectrum.

STELLAR SPECTROSCOPY AT THE DETROIT OBSERVATORY.—Vol. ii. of the Publications of this observatory, belonging to the University of Michigan, has lately been distributed, and contains a great number of interesting studies of stellar spectra. Two may be instanced in particular: the study of variable stars of Class Md, by Mr. Paul W. Merrill, traces the changes of spectra that accompany the change of light, and discusses various suggestions of the cause of variability. The one favoured by the author is somewhat analogous to the "geyser" theory, but, instead of imagining a solid or viscous crust imprisoning the gases within, he substitutes a smoke-veil composed of condensing gases (calcium is especially suggested) in the upper regions of the stellar atmosphere. This would act as a screen confining the heat of the photosphere, until the accumulation of heat sufficed to vaporise the screen. When the solid-crust theory was propounded these stars were thought to be near the end of their careers as suns, but from the smallness of their proper motions it now appears that they are mostly giants.

The other paper, by Mr. Laurence Hadley, deals with the elements of ζ′ Ursæ Majoris, the first spectroscopic binary discovered. The orbit is fully discussed from several series of observations. The period is 20·53644 days, the eccentricity is 0·518, and the masses of the components $\times \sin^3 i$ are respectively 1·83 and 1·79 in terms of the sun. It is noted that Prof. Joel Stebbins finds no evidence of light variation.

Meteorology at Hong-Kong.

MONTHLY Meteorological Bulletins for the Royal Observatory at Hong-Kong for a considerable period to August, 1919, have recently been received. They contain detailed results of observations made at the observatory and the daily weather reports from various stations in the Far East, prepared under the direction of Mr. T. F. Claxton. For Hong-Kong hourly values are given of barometric pressure, temperature of the air and evaporation, direction and velocity of wind, amount of rainfall, and duration of sunshine. All the hourly observations are measured from the self-registering records. Three-hourly observations are made of the character and direction of motion of the clouds. Daily values are also given of the several meteorological elements. The normals used for comparison with the means are for the years 1884 to 1918, a period of thirty-five years. From 1916 the daily and mean hourly values of the principal meteorological records have been published in both C.G.S. and British units, and with the January Bulletins tables are given for the conversion of the several elements to the respective units. Information is also supplied for the reduction and correction of the instrumental observations. The December Bulletins give tracks of typhoons and depressions in the Far East for the year, and the divergence in the several months is well shown. With the Daily Weather Reports, which contain observations from forty-five stations in the Far East, notices are given of the warning to coast ports, which commonly state the position of typhoons when such are in progress, and forecasts are given daily for the twenty-four hours ending at noon.

The annual report for 1917 contains a comparison of the Beckley anemograph with the Dines instrument, extending over eight years; the differences are remarkably consistent until the summer of 1917, when for some unexplained reason, although noticed, the differences vary. A Richard dry- and wet-bulb thermograph has been set up to replace the Kew photographic thermograph. In section ix. reference is made to sympiesometer observations, and hourly observations are said to have been made for upwards of a year to test the popular belief in the sympiesometer as a weather forecaster. The remarks scarcely seem to refer to a sympiesometer, which was essentially a sailor's barometer in the first half of the nineteenth century. It seems rather that the instrument tested

is a camphor glass or chemical weather glass, long acknowledged to be of no real scientific value. The report for 1918 deals with the corrections to be applied to the readings of an unaspirated wet-bulb thermometer in an "Indian" shelter to reduce them to those of an aspirated thermometer at definite wind velocities and for different depressions of the wet bulb. With the lighter wind velocities, of 1–5 m.p.h., and for the larger depressions of the wet bulb, say amounting to 6°–10°, the subtractive correction to the unaspirated wet bulb amounts to 1° or slightly more. Three thousand three hundred and seventy-five observations have been dealt with, but as yet no definite scheme has been decided upon. The matter has been considered in correspondence with the British Meteorological Office.

Milk Production of Ayrshire Cattle.

THE critical genetic study of a character such as that of milk production in cattle, which is highly subject to environmental influences, cannot be carried out effectively until a fairly comprehensive knowledge of the normal variation of the character has been acquired. To this end Prof. Raymond Pearl and Mr. J. R. Miner have carried out a biometrical analysis of the normal individual variation in the milk flow and the fat content of the milk of Ayrshire cattle, the results of which are summarised in a contribution to the *Journal of Agricultural Research* (vol. xvii., No. 6). Their study is based on the records of Ayrshire cattle for the years 1908 and 1909 published in the reports of the Ayrshire Cattle Milk Records Committee of Scotland, more than three thousand records in each year being used for the purpose. Amongst the many important conclusions arrived at mention may be made of the indications that about one-half of the observed variation in milk-production results from the varying genotypic individuality of the animals with respect to this character, the remainder resulting from varying environmental influences. The udder as a secreting organ is compared with the oviduct of a hen, and it is shown that the latter operates with somewhat less variability than the former, having regard to the absolute weight of the product in the two cases.

The change in mean weekly yield of milk with advancing age is found to be represented by a logarithmic curve, the absolute amount of milk produced per unit of time increasing, though at a decreasing rate, with the age of the cow to a maximum, which was found to be when the cow is ten to eleven years old. The mean fat percentage of the milk was found to decline with advancing age until the tenth year of the cow's life, after which it remains about constant.

The Ignition Points of Liquid Fuels.

IN a paper read before the Institution of Petroleum Technologists on January 20, Mr. Harold Moore described a number of determinations of the ignition point of commercial fuels which are, or might be, used in internal-combustion engines. His ignition meter, somewhat similar in principle to that designed by Holm, consists of a steel block, heated from below, in the upper surface of which a hollow is made to take a crucible of platinum, nickel, or quartz. The air or oxygen supply passes through a hole in the block before entering the crucible, so as to pre-heat it to the temperature of the crucible, which is given by a resistance thermometer placed in a hole drilled in the block near the crucible. A cover to protect the crucible from draughts is screwed on to the block, and a drop of the liquid fuel is introduced through a hole in this cover and falls on to the bottom of the crucible. After an interval, more or less prolonged, an explosion is heard and a flame seen if the temperature is above the ignition point. This interval may be as long as thirty seconds or more, and there is no doubt that quiet combustion takes place during this period, and such combustion is very marked in the case of ether. On the other hand, the evaporation of the drops of liquid must produce local cooling, and, unless the fuel is quite homogeneous, the ignition point found must in many cases be that of the last portion to evaporate.

But, in spite of certain inherent defects, the method gives a valuable comparative test of different fuels—a test which is quick and easy to apply.

Mr. Moore recommends the use of ordinary compressed oxygen instead of air as giving more concordant results and as having a concentration at atmospheric pressures more nearly like that used in motor engines. Most hydrocarbon liquids tested in air gave ignition points from 100° C. to 200° C. higher than in oxygen; but, curiously enough, Mr. Moore found that in an atmosphere containing 70 per cent. of carbon dioxide and 30 per cent. of oxygen the ignition point of kerosene was almost the same as in pure oxygen. A few ignition points from Mr. Moore's lists may be quoted:

Ignition Point.

Fuel	In oxygen °C.	In air °C.
Taxibus spirit (Anglo-American Oil Co.)	272	396
Anglo-Persian oil	254	408
Anglo-Mexican oil	259	417
Normal hexane	287	—
Benzene	620	—
Ethyl alcohol	395	518
Ether (methylated)	190	347
		In silica crucible
Hydrogen	—	678

In the case of mixtures of two liquids of very different ignition points the addition of about 20 per cent. of the more easily inflammable liquid suffices to reduce the temperature substantially to that of the lower constituent; for instance, the addition of 20 per cent. of ether (ignition point 206°) to xylol (ignition point 555°) reduced the ignition point of the mixture to 246°.

Naval Research and Experiment.

TO ensure that the full benefits of science shall be secured to the Naval Service, a Department of Scientific Research and Experiment has been set up under the Third Sea Lord and Controller. As the Scientific Adviser of the Admiralty, and in charge of this Department, Mr. F. E. Smith, F.R.S., has been appointed with the title of Director of Scientific Research. It is the duty of the Department to keep the Navy in touch with outside scientific establishments and to ensure that the work at the various naval experimental establishments proceeds with full cognisance of scientific progress and methods. The Director of Scientific Research will work in close association with the Naval Staff, thus ensuring that naval policy is framed with due consideration of the possible practical applications of scientific progress in relation to naval needs, and enabling requirements as to types and weapons to be formulated with a knowledge of the latest scientific possibilities.

Consultations with outside scientific institutions will be resorted to, both to ensure against overlapping and with the view of utilising such of their researches and experiments as appear likely to prove of value to the Naval Service.

At present there exists under the Department a naval research laboratory at Shandon. This establishment was set up during the war with the primary object of investigating methods of counteracting the enemy's submarine menace. It has performed, and is performing, good service; but Shandon is a great distance from the experimental schools, the various scientific institutions, and the Admiralty, and it has therefore been decided that, so soon as suitable accommodation can be provided elsewhere, such of the work as requires sea environment, together with the scientific *personnel* associated with it, will be removed to a suitable existing naval establishment, and the remainder, which does not in its early stages require a sea environment, will be transferred to a naval research institute. This institute, under the Director of Scientific Research, will adjoin the National Physical Laboratory at Teddington. It will be entirely controlled by the Admiralty, but its close association with the National Physical Laboratory will offer exceptional facilities for co-operation, and the staff of the research institute will have the advantage of personal acquaintance with the work being carried out at the laboratory. The Department of Scientific and Industrial Research will be consulted in all cases when the results of investigations are likely to be of use to the general community.

To ensure effective co-operation and contact with naval thought, naval officers will frequently visit the research institute, and the scientific staff will work for lengthy periods at naval establishments, and at times go to sea

Education and Science in the Civil Service Estimates for 1920–21.

THE Estimates for Civil Services for the year ending March 31, 1921 (Class IV.: Education, Science, and Art), have now been published. Among the increased grants compared with those of last year are:—Board of Education, 12,983,094*l.*; British Museum, 74,519*l.*; Scientific Investigation, etc., 81,442*l.*; Scientific and Industrial Research, 246,845*l.*; Public Education (Scotland), 2,200,000*l.*; Public Education (Ireland), 185,735*l.*; and Science and Art (Ireland), 20,917*l.* As the Geological Museum and Geological Survey are now under the Department of Scientific and Industrial Research, their grants of 7560*l.* and 30,043*l.* respectively represent part of the increase of 246,845*l.* to that Department. The grant for scholarships, exhibitions, and other allowances to students in technical schools and colleges is increased from 17,460*l.* to 34,350*l.* In addition, there are new grants of 15,000*l.* for scholarships tenable at universities, and expenses incidental to them, and 250,000*l.* to local education authorities for maintenance allowances at places of higher education. The total amount of the grants in aid of universities, colleges, medical schools, and like institutions in the United Kingdom is about 1,000,000*l.*; there is also a special grant of 196,000*l.* for extraordinary expenditure. The grant for assistance towards the higher education of ex-officers and men of like standing is 3,000,000*l.*, compared with 2,000,000*l.* for 1919–20. The grant under the Royal Society shows an increase of 9000*l.*, and includes 2000*l.* for subscriptions to international research associations. The subjoined summary and details are extracted from the Estimates:—

SYNOPSIS.

United Kingdom and England.

	£
Board of Education	45,755,567
British Museum	294,233
National Gallery	29,956
National Portrait Gallery	9,824
Wallace Collection	15,953
London Museum	5,412
Imperial War Museum	50,000
Scientific Investigation, etc.	208,416
Scientific and Industrial Research ...	518,298
Universities and Colleges, United Kingdom, and Intermediate Education, Wales	945,700
Universities, etc., Special Grants ...	196,000
Serbian Relief Fund (maintenance and education of young Serbians in this country)	25,000

Scotland.

Public Education	6,877,220
National Galleries	11,661

Ireland.

Public Education	3,358,371
Intermediate Education	90,000
Endowed Schools Commissioners ...	1,042
National Gallery	4,650
Science and Art	211,415
Universities and Colleges	86,000
	58,694,718

DETAILS.

Scientific Investigation, etc.

	£	£
Royal Society:		
(i) Grant in aid of:—		
Scientific investigations undertaken with the sanction of a Committee appointed for the purpose (including non-recurrent grant of 5000*l.*) ...	11,000	
Scientific publications	1,000	
Subscriptions to international research associations ...	2,000	
		14,000
(ii) Grant in aid of salaries and other expenses of the Magnetic Observatory at Eskdalemuir		1,000
Total for Royal Society ...		15,000
Royal Geographical Society		1,250
Marine Biological Association of the United Kingdom		1,000
Royal Society of Edinburgh		600
Scottish Meteorological Society		100
Royal Irish Academy		1,600
Royal Irish Academy of Music		300
Royal Zoological Society of Ireland ...		500
Royal Hibernian Academy		300
British School at Athens		500
British School at Rome		500
Royal Scottish Geographical Society ...		200
National Library of Wales		12,000
National Museum of Wales		25,500
Solar Physics Observatory		3,000
North Sea Fisheries Investigation ...		1,250
Imperial Mineral Resources Bureau ...		10,750

	£
Royal Academy of Music	500
Royal College of Music	500
Medical Research Council	125,000
British Institute of Industrial Art ...	5,500
Edinburgh Observatory	2,566
Department of Scientific and Industrial Research.	
Salaries, wages, and allowances	29,235
Travelling and incidental expenses ...	1,950
Grants for Investigation and Research:	
(1) Investigations carried out by learned and scientific societies, etc.	13,800
(2) Investigations directly controlled by the Department of Scientific and Industrial Research	40,928
(3) Students and other persons engaged in research	38,300
(4) Expenses of Research Boards for co-ordination of Government research ...	200,000
Total	293,028
Fuel Research Station	40,882
Geological Museum	7,560
Geological Survey of Great Britain ...	30,043
National Physical Laboratory[1]	203,000
Appropriations in Aid :—	
Contributions of co-operating bodies ...	1,550
Refund of unexpended balance of grants	300
Testing fees at Fuel Research Station ...	1,000
Sales of by-products at Fuel Research Station	2,500
Testing fees at the National Physical Laboratory, charges for special investigations, and repayments by the Road Board, India Office, etc., for services rendered by the National Physical Laboratory	55,000
Balance of accrued interest at March 31, 1921, on the Fund of the Imperial Trust for the encouragement of scientific and industrial research, for which 1,000,000*l.* was voted in 1917–18	27,050
Total for Appropriations in Aid	87,400
Universities and Colleges, United Kingdom.	
Birmingham University	35,000
Bristol University	17,000
Bristol Merchant Venturers' Technical College	2,000
Cambridge University, Medical Department	8,500
Durham University	2,000
Durham, Armstrong College	22,000
Durham College of Medicine	3,800
Leeds University	33,000
Liverpool University	40,000
London University	8,000
London, Bedford College	13,000
,, East London College	11,000
,, Imperial College of Science and Technology	52,000
,, King's College, Household and Science Department	4,000
,, King's College, including King's College for Women	25,000
London, School of Economics	10,000
,, School of Oriental Studies ...	4,000
,, University College	39,000
,, Westfield College	3,000
,, Charing Cross Hospital Medical School	1,000
,, King's College Hospital Medical School	700
,, London Hospital Medical College	6,000
,, Middlesex Hospital Medical School	2,000
,, Royal Dental Hospital, School of Dental Surgery	1,000
,, (Royal Free Hospital), School of Medicine for Women	4,000
,, St. Bartholomew's Hospital Medical School	5,000
,, St. George's Hospital Medical School	700
,, St. Mary's Hospital Medical School	1,900
,, St. Thomas's Hospital Medical School	4,500
,, School of Tropical Medicine ...	1,100
,, University College Hospital Medical School	4,000
,, Westminster Hospital Medical School	300
Manchester University	40,000
Manchester College of Technology ...	7,000
Nottingham University College	11,000
Oxford University Engineering Department	500
Reading University College	12,000
Sheffield University	21,000
Southampton University College	5,000
Total England	461,000
University of Wales	6,500
Aberystwyth University College	14,000
Bangor University College	14,000
Cardiff University College	18,000
Total Wales	52,500
Edinburgh University	53,000
Glasgow University	48,000
Glasgow Royal Technical College ...	3,000
Aberdeen University	32,000
St. Andrews University, including Dundee University College	29,000
Total Scotland[2]	165,000
Belfast, Queen's University	8,000
Cork University College	6,000
Dublin University College	10,000
Galway University College	3,000
Total Ireland[3]	27,000
Universities and Colleges, United Kingdom, unallocated grant	210,500
Total for Universities and Colleges, United Kingdom, Grant in Aid[4]	916,000

[1] Services rendered without payment for other Government Departments are estimated as follows:—Admiralty, 7,500*l.*; Air Ministry, 40,000*l.*; Ministry of Munitions, 7,000*l.*; War Office, 2,150*l.*; H.M. Office of Works, 500*l.*; Board of Trade, 1,000*l.*; Works undertaken at the instance of the Advisory Council, 8,000*l.*

[2] This sum includes 42,000*l.* payable to Scottish Universities under Section 25 of the Universities (Scotland) Act, 1889, and is in addition to an annual sum of 30,000*l.* payable to these Universities from the Local Taxation (Scotland) Account under Section 2(2) of the Education and Local Taxation Account (Scotland) Act, 1892.

[3] In addition to 84,000*l.* provided in Class IV., 28.

[4] This sum, together with 84,000*l* provided in Class IV., 28, is intended to raise to 1,000,000*l.* the total amount of the grants paid out of the Exchequer during the year 1920–21 for the maintenance of University Institutions in the United Kingdom.

The Native Tribes of Western Australia.

AT a meeting of the Royal Anthropological Institute on April 13, Sir Everard im Thurn, president, in the chair, Mr. G. O. Neville read a paper on "The Aborigines of Western Australia: Their Treatment and Care." In introducing the speaker, the president laid stress upon the importance of papers dealing with the practical side of native questions. It was often said that the Government did not assist scientific societies enough, but he was sometimes in doubt whether scientific societies on their side gave sufficient assistance to the Government.

Mr. Neville said that the aborigines of Western Australia were most numerous in the north, diminishing as they came nearer civilisation, until almost extinct where the white man has lived since the early days of occupation. By nature a nomadic race, they live by hunting alone and cultivate nothing. They communicate with each other by means of a cipher, intelligible only to themselves, cut upon message sticks, or *Bambarro*, the bearer of which is granted a safe passage through hostile tribes. Numbers of crude figures, representations of beasts, birds, or reptiles, are to be found drawn in coloured pigments upon flat rocks or inside caves in the far north. The gradual disappearance of the natives continues unceasingly, in spite of constant effort. This is due to change of food, their hunting-grounds being occupied by the squatter, and the necessity for their having to clothe themselves and live more or less under shelter. The aborigines do not believe that any person dies a natural death, but suppose the deceased to have been *boulyaed* (bewitched) by some member of another tribe, and it becomes the duty of a near relative, generally a brother of the dead person, selected by the *Bulyas* or medicine-men, to avenge his death by killing the supposed murderer or another one of the tribe to which the murderer is supposed to belong. One of the most remarkable means of disposing of the dead, known as the stone system, occurs in the north. There the body of the dead person is elevated to a platform of sticks built in a tree, a layer of large stones being placed immediately beneath the body. The stones represent individuals who might have caused the death of the victim; and if the fat from the body, evaporating in the heat of the sun, falls upon any stone, the individual represented by that stone is the one upon whom vengeance will sooner or later fall at the hands of the near relatives of the deceased person. If no fat falls, a near relative will, after the removal of the body to an adjacent ant-heap, where only the bones are soon remaining, sleep upon the pile, and it will be revealed to him in a dream which is the selected stone.

No native can be employed except under a permit issued by a Protector. Generally speaking, the treatment of Western Australian natives at the hands of their employers leaves little to be desired. The Aborigines Act provides the necessary machinery for bringing offenders to book. The Chief Protector being constituted by law the legal guardian of every aboriginal and half-caste child until the age of sixteen, it is possible to remove any child from undesirable surroundings. Some eighty Protectors, under the Chief Protector, are resident in various parts of the State where there are natives. Seventy Government relief stations provide assistance for indigent and destitute natives. The Department owns cattle settlements in Kimberley, and two farming and industrial settlements have been established recently in the south for the reception of indigent and aged people, with special provision for the care and training of orphan children. The reserves upon which these settlements are established are for the natives only, and whites, other than the staff employed, are rigidly excluded by law. The provision of medical attendance has been the special care of the State; all natives receive free advice, medicine, and hospital treatment in case of sickness. The nine mission stations in Western Australia, nearly all subsidised by the State, have done useful work, especially in the care and rescue of children. Though the people are dwindling away, the work of the Department must go on, in the hope that the last days of a dying race can be made the easier and happier.

In declaring the subject open for discussion, the president said that the cause of the decrease in a native population when it came into contact with civilisation was its failure to adapt its psychological constitution to changed circumstances.

Dr. Corney said that as a result of his experience in dealing with immigrant labour—male only—in Fiji, he had arrived at the conclusion that the type of soil had an important effect on certain groups; for instance, an alluvial soil was fatal to Gilbert Islanders and Solomon Islanders, although the former throve on sandy soil such as that of the islands on which coconuts were grown, and the latter made excellent sailors. It was also evident that all were peculiarly susceptible to the attacks of micro-organisms from which the European population was to some extent immune, as shown by the virulence of the epidemics of measles and influenza.

Mr. N. W. Thomas pointed out that Pater Schmidt has shown that in the north mode of burial and language coincide in distribution, and asked whether the distribution of drawings also coincided with platform burial and language.

Prof. Arthur Keith said that if we were placed in the Australian desert and asked to live the life of the aborigines, he doubted whether we would survive. Would we not rather die as they die in our environment? When they were brought into contact with our civilisation we asked them to make a jump of perhaps two thousand generations within a lifetime; to change at once from the life of a prince to that of civilisation, the life of a horse in a mill. The governing factor in deciding the fate of native populations lay in the domain of psychology. Here the man of science came into touch with the practical problem, for he was trying to understand the back of the black man's mind.

Miss Freire-Marreco compared the measures adopted in Western Australia with those which had been followed in the United States of America, especially in relation to the dying out of the native races. Until about ten years ago the native races there had diminished rapidly. Since then, however, the Indian population had been on the up-grade, owing largely to the attention paid by the Central Government to the food-supply and the checking of tuberculosis and other diseases by isolation and the inculcation of sanitary and hygienic rules.

University and Educational Intelligence.

MR. F. A. HERON has given to Queen's University, Belfast, the sum of 5000*l.* to provide the necessary equipment for teaching physical chemistry, and 1000*l.* towards the provision of accommodation for the department.

IN connection with the faculty of medicine of the University of Birmingham, a course of ten weekly lectures (free to medical men) on "Principles of Psychotherapy" is to be given by Dr. W.

McDougall, F.R.S., in the medical school buildings of the University, beginning on Friday, April 30.

THE subject for the Jacksonian prize of the Royal College of Surgeons of England for 1921 is "The Pathology, Diagnosis, and Treatment of Tuberculous Disease of the Spinal Column with its Complications."

APPLICATIONS for not more than three Ramsay memorial fellowships for chemical research will be considered by the trustees at the end of June next. They must be received by, at latest, June 15 by Dr. W. W. Seton, organising secretary, Ramsay Memorial Fund, University College, Gower Street, W.C.1. The fellowships will each be of the annual value of 250*l*., with, possibly, a grant of not more than 50*l*. per annum for expenses, and tenable for two years, with the possible extension of a year.

DR. J. H. ANDREW has been appointed to the chair of metallurgy in the Royal Technical College, Glasgow, vacant by the transfer of Dr. Desch to the University of Sheffield. Dr. Andrew graduated in Manchester University with first class honours in chemistry. After research work in metallurgy, he received the M.Sc. degree in 1908, and was awarded the Dalton scholarship. He continued metallurgical investigations in the University laboratories until 1914, was appointed research fellow and demonstrator in 1916, and Carnegie scholar of the Iron and Steel Institute. He received the degree of D.Sc. in 1915. Since June, 1914, Dr. Andrew has been chief of the Metallurgical Research Department of Sir W. G. Armstrong, Whitworth, and Co., Ltd., Manchester, and has gained a wide experience in the metallurgical industry, having had unlimited scope for studying practice and for research. His publications include a number of important papers presented to the leading metallurgical societies.

Societies and Academies.

LONDON.

Royal Microscopical Society, March 17.—Prof. John Eyre, president, in the chair.—T. E. **Wallis**: The Lycopodium method of quantitative microscopy. Various methods have been devised by different workers in an attempt to find a satisfactory method of making determinations of percentage composition by means of the microscope. The most trustworthy of these require specially constructed apparatus and are applicable in certain instances only. The Lycopodium method is simple in principle, and with slight modifications may be used for all kinds of problems. The only apparatus needed is such as is used in ordinary microscopical work. The results are correct to within 10 per cent. of the amount to be determined; they can therefore be utilised with the same confidence as is the case with results obtained by many well-known chemical operations having a similar range of error.—C. **Da Fano**: Method for the demonstration of the Golgi apparatus in nervous and other tissues. The author has been able to obtain a fairly constant staining of this peculiar intracellular formation by substituting cobalt for uranium nitrate in a formula originally proposed by the Spanish biologist, S. Ramon y Cajal. Da Fano's modification can be easily applied to all sorts of tissues, as proved by an interesting series of quite demonstrative microscopic preparations and lantern slides shown at the meeting. Another step has thus been taken in the study of the "internal apparatus" discovered by Golgi in 1898, the functions of which, however, still remain quite mysterious to biologists and physiologists.

Linnean Society, March 18.—Dr. A. Smith Woodward, president, in the chair.—Prof. J. **Small**: The chemical reversal of geotropic response in roots and stems. It was stated that when roots are placed horizontally in a moist atmosphere rendered very faintly alkaline by ammonia vapour they tend to grow upwards. When stems are treated in a similar way with acetic acid vapour they tend to grow downwards. These experiments form preliminary confirmation of a theory of geotropic curvature which has been elaborated as a correlation of previous work on the electrical conductivity of roots with data accumulated by other investigators.

Aristotelian Society, March 22.—Prof. Wildon Carr in the chair.—Clement C. J. **Webb**: Obligation, autonomy, and the common good. It was contended that the notion of obligation in which Kant rightly found the essential feature of our moral consciousness cannot be directly derived (as Green seems to suppose) from the notion of a "common good"; that, on the contrary, the notion of a "common good," and the closely connected notion of a "general will," derives its significance for ethics, and eventually for politics also, from its connection with the notion of obligation; and that this makes it necessary for any truly ethical conception of the State to retain the idea of "authority," as ascertained, indeed, through the general will, because only thus can it be recognised as authority—viz. the community for itself; not, however, as in itself merely the result of the general will, but as the expression of an absolute factor therein, which perhaps may be best described as the sovereignty of God. To the thought expressed in Kant's choice of the word "autonomy" to express the status of the good will may be traced along one line of descent the anti-authoritarian tendency in contemporary ethics and politics.

Geological Society, March 24.—Mr. R. D. Oldham, president, in the chair.—Mrs. Eleanor M. **Reid**: Two pre-Glacial floras from Castle Eden (County Durham). The seeds examined were obtained by Dr. C. T. Trechmann from pre-Glacial clays, found in fissures of the Magnesian Limestone at Castle Eden. The clays were carried by the Scandinavian ice from the area now covered by the North Sea. The study proved the presence of two seed-bearing clays of different ages, the earlier being undoubtedly Pliocene. The Pliocene age is confirmed by M. P. Lesne, who determined the insect remains found intermingled with the seeds. While the work was in progress material from the base of the Pliocene of Pont de Gail (Cantal) gave knowledge for the first time of a seed flora of known age, low down in the Pliocene; it showed that the rate of change in the character of the West European Pliocene flora was slower than had been suggested by Clement Reid and the author. A critical comparison was made between the Cromerian, Teglian, Castle Eden, Reuverian, and Pont de Gail floras on the bases of the percentages of all exotics, and of Chinese-North American exotics—that is, plants now inhabiting the Far East of Asia or North America, but not Western Europe—in each flora. The result proved the Reuverian to be Lower Pliocene, not top of the Middle Pliocene (as formerly suggested), and the Castle Eden flora to be Middle Pliocene. Therefore a study of fossil seeds had made it possible to discriminate between strata intimately mixed *in situ*, and to determine their geological age when unknown.—Mrs. Eleanor M. **Reid**: A comparative review of Pliocene floras, based on the study of fossil seeds. By plotting as a curve the percentages of all exotics, and of Chinese-North American exotics, from the five floras (see above paper), it was found that all lay

along a smooth curve, part of which indicated changes in the Pliocene and part in the Miocene. From this curve certain deductions are drawn, namely: (1) The study of living and fossil seeds can lead to accurate specific determinations. (2) The study of fossil seeds is as accurate a method of determining geological age as is palæontology, and the age indicated for the Reuverian and Castle Eden floras is approximately correct. (3) The destruction and supplanting of the Chinese-North American exotic flora began about the Middle Miocene, at the time when the great European and Asiatic Alpine ranges attained their maximum uplift; but it was to these trans-continental barriers that Clement Reid and the author attributed the extermination of this flora. Therefore, the curve gives strong and independent confirmation of the truth of their theory, and is in accord with the findings of stratigraphy and palæontology. (4) The curve indicates an incoming flora—the present flora of Western Europe and, in part, of Central and Southern Europe—which first appeared in the Miocene. Of this the aquatic element is now chiefly circumpolar in distribution, whereas the dry-soil element mainly centres in the Himalayas. (5) The incoming flora only in part survived in Western Europe; the destruction became greater after the Middle Pliocene; the cause of this is unknown.

CAMBRIDGE.

Philosophical Society, February 23.—Mr. C. T. R. Wilson, president, in the chair.—Prof. **Seward**: The origin of the vegetation of the land. A brief consideration of questions raised by Dr. A. H. Church in a recent memoir on "Thalassiophyta and the Subaerial Transmigration" (Oxford, 1919). "The beginnings of botany are in the sea." Life evolved from the ionised water of a continuous world-ocean two miles in depth. The plankton epoch; unicellular, free-floating plants. The Benthic epoch was initiated when portions of the earth's crust rose to within the reach of light and plants were able to establish themselves on the ocean-floor. Development during the Benthic epoch of complex anchored marine plants. The epoch of the land flora began with the emergence of areas of land and the transference of plants from the hydrosphere to the atmosphere.

MANCHESTER.

Literary and Philosophical Society, March 2.—Sir Henry A. Miers, president, in the chair.—W. J. **Perry**: The search for gold and pearls in Neolithic times. Further research on the distributions of early sites of civilisation and of the sources of gold and pearls has produced a mass of evidence to substantiate and enlarge the thesis of an earlier paper by the author on "Megalithic Monuments and Ancient Mines." The evidence now suggests that not only megalithic monuments, but also early sites in general, marked the settlements of seekers after gold and pearls, amber and purple having also played their part in attracting strangers. These settlements are mostly localised in the basins of rivers containing gold or pearl-bearing mussels, and the distribution map shows that the early seekers for these objects did not allow much to escape them. Further inquiry will be necessary in order to determine the precise age when this search began.—C. L. **Barnes**: Einstein's theory of space and time.

EDINBURGH.

Royal Society, March 1.—Prof. F. O. Bower, president, in the chair.—Prof. J. C. **Ewart**: The nestling feathers of birds. This paper embodied certain facts of observation in regard to the development of nestling feathers which did not harmonise with the view generally taken that feathers were originally developed out of scales. Three facts of fundamental importance should be borne in mind: (1) The geological record has hitherto told us nothing about the evolution of feathers; (2) the embryological record affords no evidence in support of the view that scales grew longer and lighter and, after much spreading and splitting, became feathers; and (3) the true feathers of modern birds are, as a rule, derived from small umbels consisting at the outset of barbs, which result from the splitting of the intermediate layer of cells of a simple dermic papilla similar to the papillæ of the tongue of ducks. A study of simple nestling feathers (prepennæ) leads one to believe that the plumage of primeval birds consisted of umbels (protoptiles) which differed but little from the bundles of hair found in the jerboa and certain other mammals, or of umbels consisting of barbs armed with barbules, as in the feathers forming the first nestling coat of penguins, or of feathers with practically all the structures now associated with true feathers. In course of time feathers of a different type were evolved, which, as they grew, pushed from the skin, and for a time carried on their tips the feathers of the first generation. The second kind of feathers (mesoptiles) are now well represented in penguins and in the emu, and a remnant is still found in ducks and geese; whether the body of Archæopteryx was clothed with protoptiles or with mesoptiles or with plumose feathers it is impossible to say. When all the facts recently established by a study of the development of feathers are duly considered, there is no escape from the conclusion that the wing-quills are only highly specialised nestling feathers, and that it is inconceivable that the first nestling feathers were formed out of scales.—Dr. J. M'Lean **Thompson**: New stelar facts and their bearing on stelar theories for the ferns. In order to know how the complicated vascular system of adult ferns came into existence, knowledge of individual development was necessary. This has now been traced by sections in a number of specially chosen cases, and the results reconstructed into diagrams showing the individual advance. This involves the formation of a pith, inner phloëm, inner endodermis, and frequently, in the early stages of development, pockets of outer endodermis. These tissues are new creations within the vascular system formed by a static change of quality of the elements from the growing point. The solenostele and other higher forms of the vascular system arise by further modification of the structures thus acquired. This involves the formation of gaps in the vascular system, through which the pith and cortex, originally distinct, unite to form one continuous tissue. The ferns dealt with range from the primitive Schizæaceæ to the advanced Pterideæ.—Sir Thos. **Muir**: Note on Pfaffians with polynomial elements.

PARIS.

Academy of Sciences, March 22.—M. Henri Deslandres in the chair.—A. **Lacroix**: The eruptive rocks of the Pyrenees Cretaceous and the nomenclature of the modified eruptive rocks.—G. **Bigourdan**: The pupils of the Observatory of the Collége de France. The observatories of the Military School.—F. E. **Fournier**: General expressions for the resistance of water to the passage of ships floating in open air and for the wave-length of their satellite surge.—A. **Haller** and R. **Cornubert**: The constitution of the dimethyl*cyclo*hexanone obtained by methylation of the sodium derivative of α-methyl*cyclo*hexanone. From a study of the condensation products with benzaldehyde it is concluded that the dimethyl*cyclo*hexanone is unsym-

metrical.—H. **Lecomte**: The tier-like structure of certain woods.—P. A. **Dangeard**: The structure of the plant-cell and its metabolism. A critical discussion of the views of Guilliermond.—M. Maxime Laubeuf was elected a member of the division of the applications of science to industry.—N. E. **Nörlund**: A theorem of Cauchy.—Ch. **Fremont**: Work done in sawing metals by hand. A diagram and description of a pendulum support and guide for a hack-saw. There is an economy of about one-third of the labour.—J. **Vallot**: The calibration in calories of two actinometers adapted to studies in heliotherapy and agricultural climatology.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1919. Observations were possible on sixty-six days during the quarter, and the results are tabulated, showing the spots, their distribution in latitude, and the distribution of the faculæ in latitude.—M. **de Broglie**: The K absorption bands of the rare earths for the X-rays.—P. **Boucherot**: Electrical resonance in a circuit the self-inductance of which contains iron.—C. **Chéneveau** and R. **Audubert**: A nephelometer.—P. **Job**: The constitution of two cobaltammines.—J. **Guyot** and L. J. **Simon**: The combustion by mixtures of sulphuric and chromic acids of organic bodies containing chlorine. Whilst the combustion of hydrocarbons by the wet method is nearly always incomplete, out of nine chlorinated hydrocarbons seven gave correct figures for carbon and only two, pentachloroethane and hexachloroethane, gave low results.—C. A. **Kténas**: The hydrocarbon zone of Western Greece. Sixteen points are marked on a map of Western Greece where indications of oil, bituminous schists, or asphalt have been found.—P. **Fallot**: Observations on drift phenomena in the centre of the Sierra of Majorca.—C. **Störmer**: The absorption of the penetrating corpuscular rays in the earth's atmosphere following non-rectilinear trajectories.—G. **Reboul** and L. **Dunoyer**: The utilisation of cirrus clouds for weather prediction. Rules are given for weather forecasts based on the appearance of cirrus clouds, their displacement and amount. Results of the application of these rules to weather predictions are compared with the observed weather.—V. **Bjerknes**: The temperature of the upper lavers of the atmosphere.—G. **Nicolas**: The respiration of plants carrying parasitic fungi.—H. **Coupin**: The time taken by chlorophyll to develop its maximum intensity in the light.—P. **Portier**: Modifications of the testicle of birds under the influence of a diet free from vitamines.—J. **Athanasiu**: The supposed dynamogenic power of alcohol. There is no evidence of increase of muscular power at any period of time after ingestion of alcohol. The experiments described afford a further proof that alcohol is not a food utilisable by the organism.—J. E. **Abelous** and L. C. **Soula**: The action of secretin upon metabolism.—F. **Diénert**: The formation of activated sludge.—A. **Fernbach** and M. **Schoen**: New observations on the biochemical production of pyruvic acid. During the fermentation of sugar by yeast in a solution maintained neutral by chalk an appreciable quantity of pyruvic acid is formed.—J. **Legendre**: The *rôle* of domestic animals in the defence against malaria.

ROME.

Accademia dei Lincei, Class of Physical, Mathematical, and Natural Sciences, January 18.—Prof. A. Ròiti, vice-president, in the chair.—O. M. **Corbino**: A laboratory method for the production of continuous and constant electric currents of high tension.—G. **Ciamician** and C. **Ravenna**: Influence of some organic substances upon the development of plants (iv.).—A. **Angeli** and C. **Lutri**: Chemical researches on the melanins of pyrrole.—Q. **Majorana**: Gravitation (vi.). A continuation of previous researches (1918) on a rather sensational subject, namely, the screening off of gravitation by a massive spherical sheet (in practice, about 100 kg. of mercury placed between two concentric spheres). Last May the author found, or at least believed he had found, a positive effect, *e.g.* a just discernible diminution of the weight of a sphere of lead placed within the cavity of the said sheet; but later he found a slight increase in the weight instead. In the present note the author gives some further details about the improvement of his apparatus, and discusses possible perturbations of thermal and mechanical origin. The net results of his search for a gravitational screening effect are so far inconclusive.—F. **Bottazzi**: Researches on the posterior salivary gland of Cephalopodes (iii.). This note deals with the independence of secretive activity of the presence of free oxygen.—E. **Bompiani**: Metrical invariants and covariants with respect to surface deformations of higher order (species) (iii.).—A. **Rosenblatt**: A theorem of Liapounoff (to be published in the next issue of the *Atti*).—L. **Tonelli**: Primitive functions. An old mathematical subject re-inaugurated about twenty years ago by Lebesgue and others.—E. **Zavattiero**: Relation between the resistance and stress in bismuth.—C. **Ravenna**: Preliminary note on the synthesis of a peptide from aspartic acid with vegetable enzymes.—G. **Sani**: Arbusterine and its derivatives.—L. **Bernardini**: Nicotine in tobacco. A contribution to the study of the genesis and the functions of alkaloids.—E. **Pantanelli**: Influence of nutrition and radical activity upon collapse produced by cold.—A. **Trotter**: The supposed parthenocarpy of the hazel-nut and its possible characters (ii.). Results of observation and experiments are given.

L. SILBERSTEIN.

Books Received.

An Introductory Course in Quantitative Chemical Analysis. By Prof. G. McPhail Smith. Pp. x+206. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 9*s*. net.

New Zealand Plants and their Story. By Dr. L. Cockayne. Second edition. Pp. xv+248. (Wellington, N.Z.: Dominion Museum.) 7*s*. 6*d*.

The Buzzard at Home. By A. Brook. Pp. 15+12 plates. (London: Witherby and Co.) 3*s*. 6*d*. net.

A Synoptical List of the Accipitres (Diurnal Birds of Prey). By H. Kirke Swann. Part iv. Pp. vi+115–64. (London: J. Wheldon and Co.) 4*s*.

Trattato di Chimica Generale ed Applicata all' Industria. By Prof. E. Molinari. Vol. ii. Chimica Organica. Parte prima. Terza edizione. Pp. xix+624. (Milano: U. Hoepli.) 28 lire.

The Principles of Ante-natal and Post-natal Child Physiology, Pure and Applied. By W. M. Feldman. Pp. xxvii+694+6 plates. (London: Longmans and Co.) 30*s*. net.

Calcutta University Commission, 1917–19. Report. Vol. xiii. Evidence and Documents. Statistics relating to Colleges. Pp. xii+221. (Calcutta: Supt. Government Printing, India.) 1.8 rupees.

Year-book of the Royal Society of London, 1920. Pp. iv+236. (London: Harrison and Sons.) 7*s*. 6*d*.

Hydration and Growth. By Dr. D. T. MacDougal. Pp. vi+176. Fluorescence of the Uranyl Salts. By E. L. Nichols, H. L. Howes, and others. Pp. 241+1 plate. Experiments in the Breeding of Cerions. By P. Bartsch. Pp. 55+59 plates. Contributions to Embryology. Vol. ix. Nos. 27 to 46. A Memorial to Franklin Paine Mall. Pp. v+554+plates. (Washington: Carnegie Institution of Washington.)

Butter and Cheese. By C. W. Walker Tisdale and J. Jones. Pp. ix+142. (London: Sir Isaac Pitman and Sons, Ltd.) 2s. 6d. net.

Panchromatism. Second edition. Pp. 32+x plates. (Ilford: Ilford, Ltd.) 6d.

Photography and its Applications. By W. Gamble. Pp. xii+132. (London: Sir Isaac Pitman and Sons, Ltd.) 2s. 6d. net.

Diary of Societies.

THURSDAY, APRIL 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Skinner: The Tensile Strength of Liquids.

ROYAL SOCIETY, at 4.30.—Prof. W. E. Dalby: Researches on the Elastic Properties and the Plastic Extension of Metals.—H. W. Hilliar: Experiments on the Pressure Wave thrown out by Submarine Explosions.—E. F. Armstrong and T. P. Hilditch: A Study of the Catalytic Action at Solid Surfaces. III. The Hydrogenation of Acetaldehyde and the Dehydrogenation of Ethyl Alcohol in the Presence of Finely Divided Metals. IV. The Interaction of Carbon Monoxide and Steam as conditioned by Iron Oxide and by Copper.—Dr. T. R. Merton: The Structure of the Balmer Series of Hydrogen Lines.—Prof. H. A. Wilson: Diamagnetism due to Free Electrons.

LONDON MATHEMATICAL SOCIETY, at 5.—G. T. Bennett: The Three-bar Sentic Curve.—S. Chapman and G. H. Livens: The Influence of Diffusion on the Propagation of Sound Waves in Air.—W. P. Milne and D. G. Taylor: The Relation between Apolarity and the Pippian-Quippian Syzygy.—G. H. Hardy and J. E. Littlewood: Some Problems of Diophantine Approximation; The Lattice-points of a Right-angled Triangle.

INSTITUTION OF CIVIL ENGINEERS (Students' Section), at 6.—C. M. Brain: Compression Refrigeration.

FRIDAY, APRIL 23.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. D. H. Paterson: Three Cases of Renal Dwarfism.—Dr. Parkes Weber: Remarkable Example of Suprarenal Tumour in a Child, of the Robert Hutchison Type (?).—(Epidemiology and State Medicine Section), at 8.30.—Dr. E. W. Goodall: Typhus in Poland, 1916-19.

PHYSICAL SOCIETY, at 5.—M. C. E. Guillaume: The Anomaly of the Nickel-Iron Alloys: Its Causes and its Applications (Guthrie Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The late W. J. Lineham: (1) The Hardening of Screw-Gauges with the Least Distortion in Pitch (referring to Water Hardening). (2) The Hardening of Screw-Gauges with the Least Distortion in Pitch (referring to Oil Hardening).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. S. Fox: Modern Developments in Motor-car Design.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Israel Gollancz: Shakespeare's Shylock and Scott's Isaac of York.

SATURDAY, APRIL 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Eccles: The Thermionic Vacuum Tube as Detector, Amplifier, and Generator of Electrical Oscillations.

MONDAY, APRIL 26.

VICTORIA INSTITUTE (at the Central Hall, Westminster), at 4.30.—Dr. T. G. Pinches: Babylon in the Days of Nebuchadnezzar.

ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—Dr. W. M. McGovern: The Development of Buddhistic Metaphysics in China and Japan.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: Aluminium and its Alloys (Cantor Lecture).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—G. B. Ash: A Factor in the Pathology of Pyorrhœa.—H. Stobie: The Problem of Infection about the Apex of the Tooth.

TUESDAY, APRIL 27.

ROYAL HORTICULTURAL SOCIETY, at 3.—P. C. M. Veitch: Magnolias.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: British Ethnology: The Invaders of England.

INSTITUTION OF CIVIL ENGINEERS (Annual General Meeting), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. F. Laidlaw: Contributions to a Study of the Dragonfly Fauna of Borneo. Part IV. A List of the Species known to occur in the Island.—Dr. R. Broom: Some new Therocephalian Reptiles from the Karroo Beds of South Africa.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Capt. C. W. R. Knight: Wild Life in the Tree Tops.

WEDNESDAY, APRIL 28.

ROYAL SOCIETY OF ARTS, at 4.30.—Brig-Gen. C. H. Sherrill: Ancient Stained Glass.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Maj.-Gen. Sir S. Brancker: Aerial Transport from the Business Point of View.

THURSDAY, APRIL 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—R. Campbell Thompson: The Origins of the Dwellers in Mesopotamia.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. J. W. Gregory: The Irish Eskers.—Miss K. M. Curtis: The Life-History and Cytology of *Synchytrium endobioticum* (Schilb.) Perc., the Cause of Wart Disease in Potato.—B. Sahni: The Structure and Affinities of *Acmopyle Pancheri* Pilger.

ZOOLOGICAL SOCIETY OF LONDON, at 4.30.—Annual General Meeting.

CHEMICAL SOCIETY, at 5.—Extraordinary General Meeting to consider the Alterations in the By-laws proposed by the Council.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Sir A. E. Shipley: Biting Insects and Children.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—A. E. McColl: Automatic Protective Devices for Alternating Current Systems.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. C. E. Kenneth Mees: The Reaction of the Eye to Light.

FRIDAY, APRIL 30.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—Major B. Binyon: A Wireless "Call" Device.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—J. E. Holmstrom: Tidal Power.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—A. P. Bale and Others: Discussion on Suggested Means of Improving and Increasing the Services of the Institution to Members.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. O. Bower: The Earliest-known Land Flora.

SATURDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. F. Chamberlin: The Private Character of Queen Elizabeth; at 5.—Annual Meeting.

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